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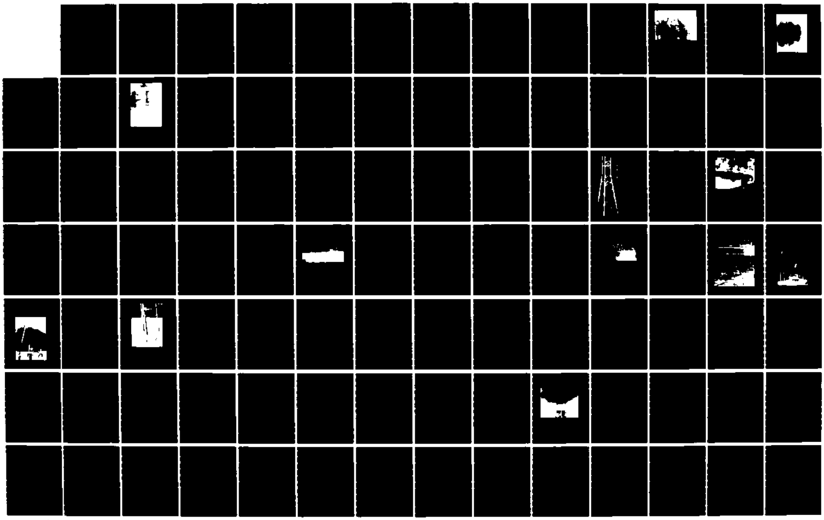

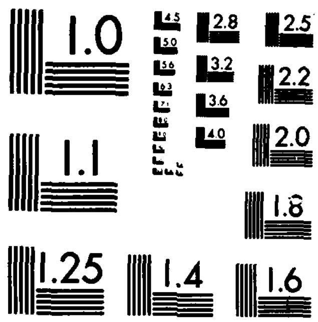

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The ACMR Tower Project was a unique endeavor for Chesapeake Division of the Naval Facilities Engineering Command (CHESNAVFACENGCOM) which was responsible for management and execution of the $13.5M construction (MCON) project. The project involved the design and construction of four off-shore (Con't)

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OCEAN TOWER CONSTRUCTION
COMPLETION REPORT

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MARCH 1978

OCEAN FACILITIES ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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ACMR TOWERS – AN OVERVIEW

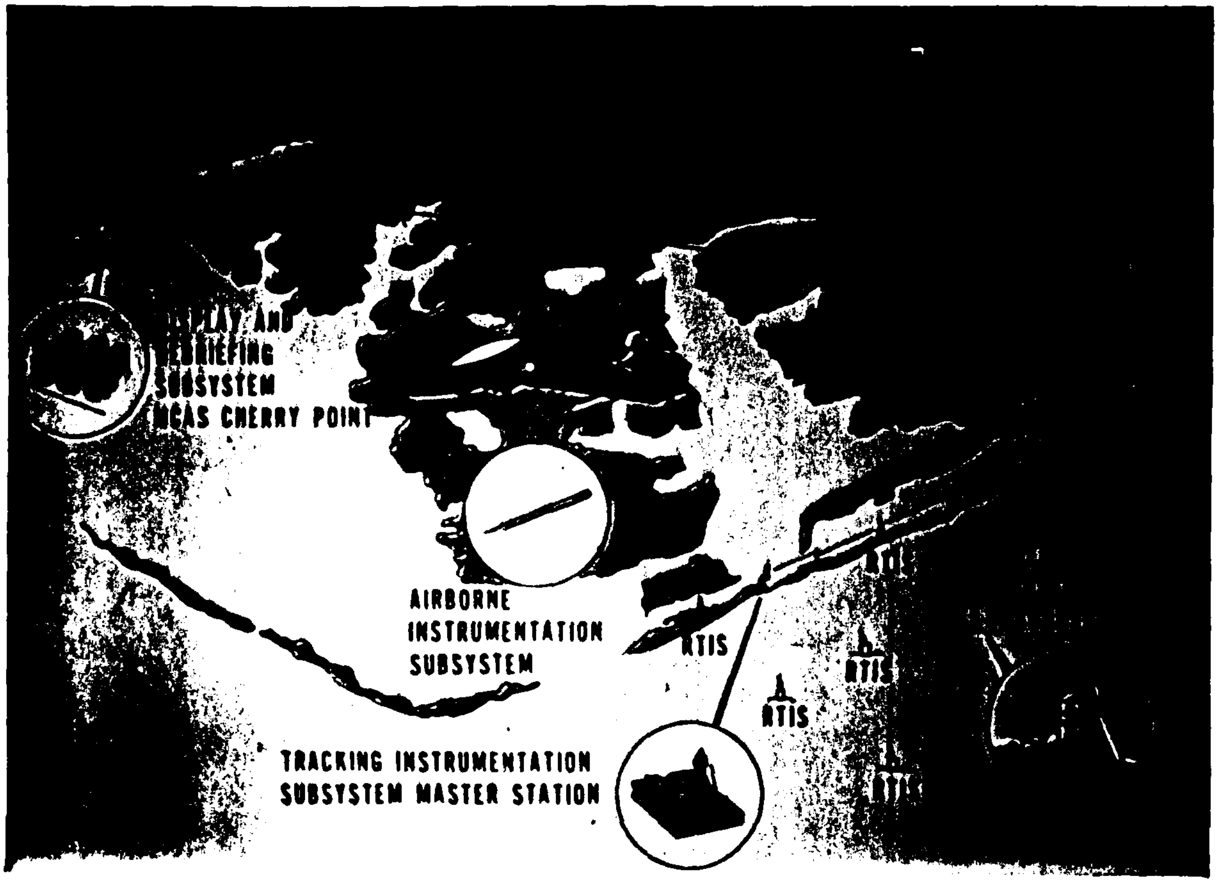
PURPOSE AND SCOPE

The ACMR Tower Project was a unique endeavor for Chesapeake Division of the Naval Facilities Engineering Command (*CHESNAVFACENGCOM*) which was responsible for management and execution of this \$13.5M construction (*MCON*) project. The project involved the design and construction of four off-shore instrumentation towers in support of the East Coast Air Combat Maneuvering Range (*EC/ACMR*).

The *EC/ACMR* provides the Navy with a unique dimension in fighter-pilot training. The range system provides for the simultaneous tracking of as many as twenty aircraft as they engage in combat/dogfight maneuvers and fire simulated (vice live) electronic missiles. Air combat and escort tactics can be developed and are evaluated by means of real-time three-dimensional displays of all range activity, while being continually monitored by highly trained ground instructors.

The range's major components are depicted in Figure 1, and consist of the following:

- an airborne instrumentation package which is mounted on each participating aircraft and transmits various aircraft positional and performance characteristics on a continual basis;
- six remote tracking instrumentation stations (*RTIS*) which receive and relay each aircraft signal;
- the master tracking instrumentation station (*MTIS*) which receives from the *RTIS*, assimilates, and computationally evaluates the aircraft characteristic data; and re-transmits this information to the display and debriefing stations;
- Display and Debriefing Station(s) which serve as the primary man-machine interface of the *ACMR* system. The



LAYOUT OF EC/ACMR RANGE

FIGURE 1

entire exercise is planned and controlled from these stations by ground instructors who monitor real-time graphic displays of all range activity. The competing pilots are later debriefed and critiqued at these stations as they observe their performance on video-type replays.

Annual range benefits are anticipated in excess of $60M savings in fuel, drone, and missile costs; cost avoidance of aircraft mishaps; and personnel costs as a result of more efficient training time and instructor utilization. In addition, the opportunity for actual combat training against other thinking pilots is expected to double pilot proficiency.

The importance of the range to Naval fleet readiness had been established on similar ranges located in the southwest which utilize terrestrial instrumentation towers only. For the east coast range, however, concerns for noise pollution was the determining factor in locating four of the remote tracking instrumentation stations, and thus the range, offshore and away from heavy population centers. Design and construction of the offshore towers for these remote stations is the subject of this report.

LOCATION

The *EC/ACMR* Towers are located in 83-106 feet of water, 15-32 miles off the coast of Kitty Hawk, N. C., Figure 2. The range is located just north of Cape Hatteras, an area so plagued by high winds and storms that it is known as *the graveyard of the Atlantic*. Environmental conditions anticipated over 20-year design life of the towers included 62-foot wave heights, 2-3 knot currents, 140 mph winds, and temperatures varying from freezing to 100° F. The required design was without historical precedent - the towers were to be installed in an area where no previous records of offshore structures existed.

ORGANIZATIONAL RESPONSIBILITIES

CHESNAVFACENGCOM first became involved with the *ACMR* tower project in the summer of 1974, when they were tasked to provide ocean engineering *consultant-type* services to the range project sponsor, Naval Air Systems Command (*NAVAIRSYSCOM*). *NAVAIRSYSCOM* was pursuing range development as an Operations Navy (*OPN*) equipment procurement through contract with Cubic Corporation, Figure 3A. Cubic had developed the electronic system and was prepared to provide the offshore towers by subcontract. During the summer of 1975, with a preliminary tower design in-hand, it was apparent that funding requirements would exceed *OPN* guidelines. Accordingly, construction of the *EC/ACMR* towers was included in the Naval Facilities Engineering Command's (*NAVFACENGCOM*) *MCON* program for FY-1976. With congressional approval of this *MCON* line item, *CHESDIV* was tasked by *NAVFACENGCOM* with procurement of the offshore towers. The revised organizational structure is depicted in Figure 3B.

LOCATION OF TOWERS

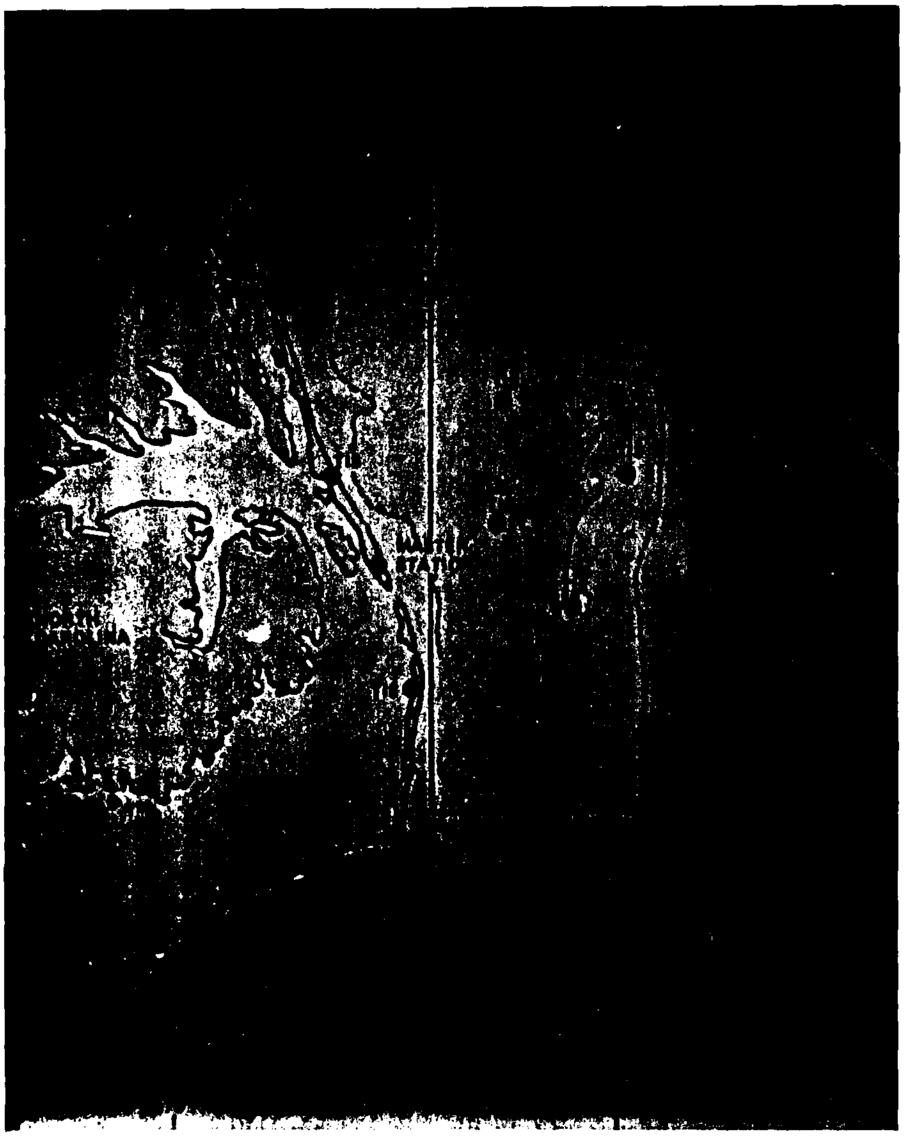
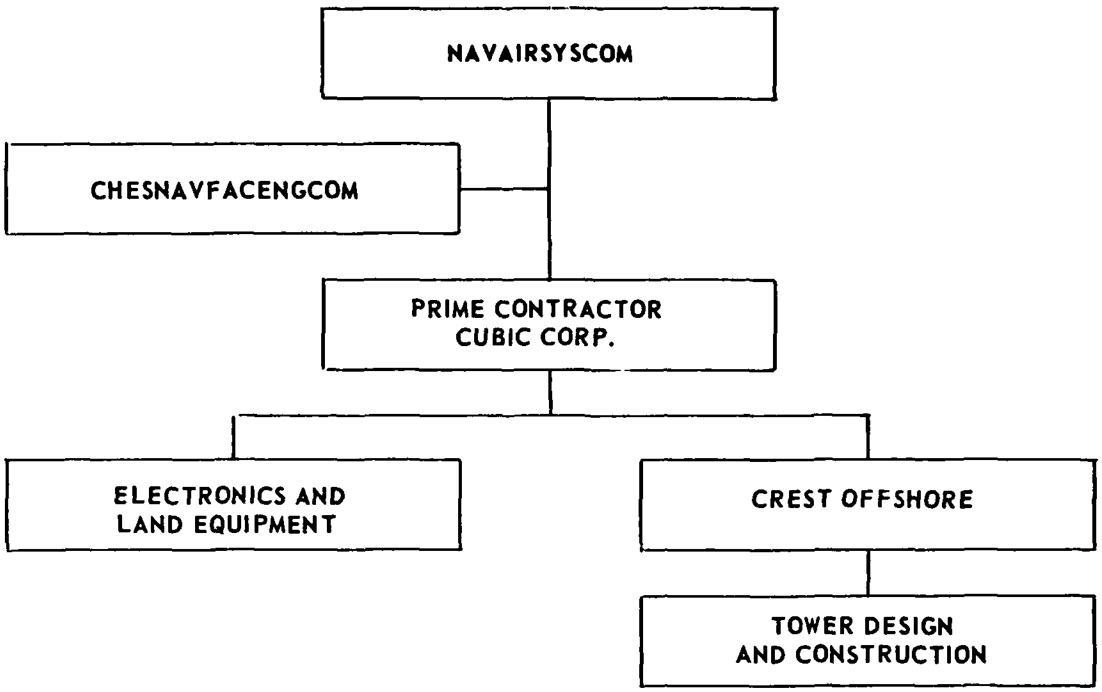


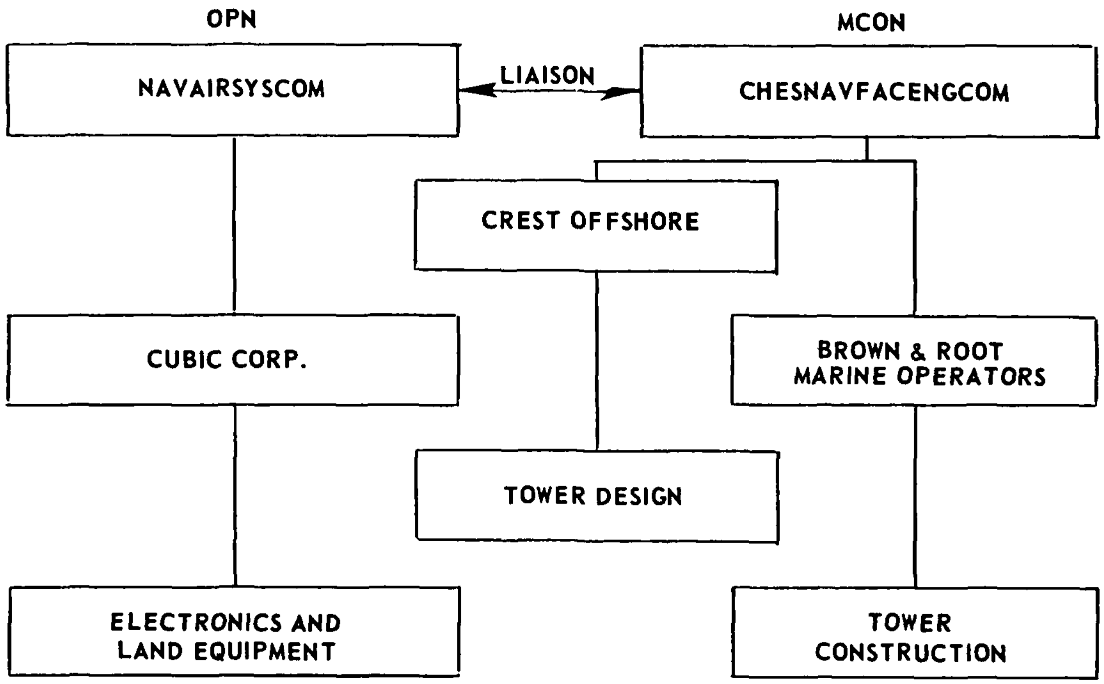
FIGURE 2

The proposed [illegible] schedule called for installation during the summer weather window (July-August) of 1978. However, due to the importance of the range to fleet readiness training, [illegible] was directed to seek a target date one year earlier, the summer of 1977. This left only 20 months for selecting an [illegible], designing,



OPN ORGANIZATIONAL STRUCTURE

FIGURE 3A



OPN/MCON ORGANIZATIONAL STRUCTURE

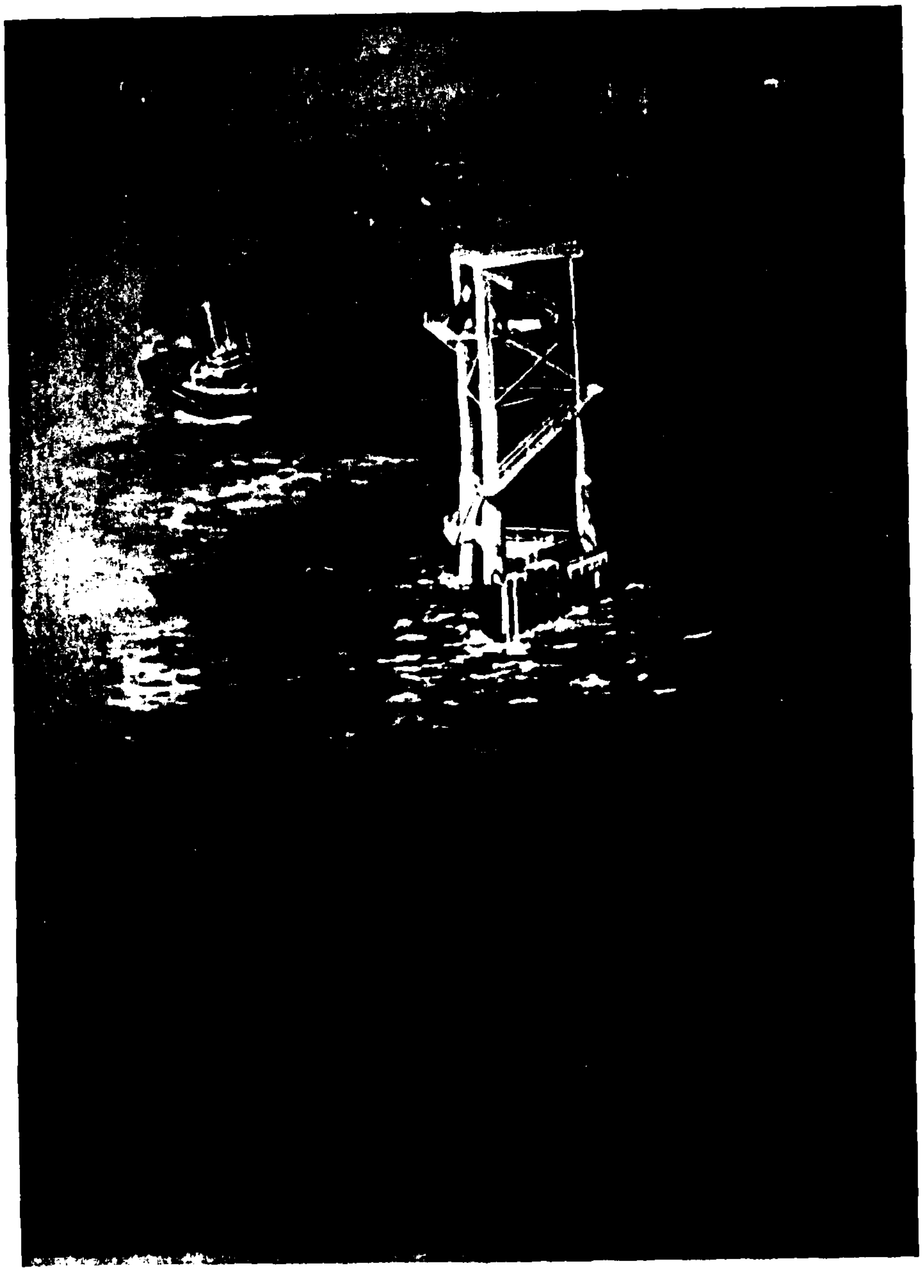
FIGURE 3B

bidding, awarding a construction contract, fabricating, transporting, and installing the four towers on site. There was little time for error or redo.

Although *CHESNAVFACENGCOM* harbors *NAVFACENGOM's* expertise in ocean facility engineering and construction, this expertise had been achieved primarily through in-house Navy construction projects. It had little experience with the offshore industry; and industry - designers and contractors both - was neither familiar nor enthused with *ASPR*, *DOD*, or Navy facility contract procedures. Essentially, offshore design and construction is procured on a cost-plus basis, with the customer assuming all risks and liabilities.

In the end, *CHESNAVFACENGCOM* was able to negotiate a fixed-price, A & E contract with Crest Offshore of Tulsa, Oklahoma, who accepted the 20-year design life liability negotiated as a cost of the fee. Crest Offshore was the same firm that developed the original *OPN* tower design for *NAVAIRSYSCOM*. In addition, *CHESNAVFACENGCOM* contracted with TERA Inc. of Houston, Texas, to provide design quality assurance (*DQA*) including an independent analysis of the A & E's design and resolution of critical design issues. A three-legged jacket-type structure, as depicted in Figure 4, was selected as the most economical.

The *ACMR* Tower Project was advertised for construction in late July 1976, in the Commerce Business Daily. Six months of contractor prequalification, various pre-bid conferences with interested and qualified contractors, and one unsuccessful bid opening followed; but, finally, in January 1977, a fixed-price contract on the basis of low bid was awarded to Brown & Root Marine Operators, Inc. The contract included unit price provisions for weather hour delays, pile driving, and remedial work such as drilling and jetting in the event of pile refusal. The contractor was faced with a tight 8-month construction schedule; nevertheless, fabrication was completed by the second week in June, and installation of the last tower was completed on 21 August 1977, 37 days before the contract completion date.



TRIPOD TOWER

FIGURE 4

[illegible] assigned a full-time Resident Officer in Charge of Construction ([illegible]) and a Resident Engineer ([illegible]) to provide construction surveillance, and to provide responsive answers and solutions to contractor questions and problems. The [illegible] was further supported with engineers and consultants from [illegible], the

NAVFACENGCOM, and industry during the fabrication, transportation, and installation phases of construction, as required.

Underwater Construction Team ONE of Little Creek, VA, was tasked by Commander, Naval Construction Forces, U. S. Atlantic Fleet, to support *CHESNFAVFACENGCOM* and the *ROICC* with an underwater inspection capability. The last of the four underwater inspections was accomplished the same day as construction completion of the fourth tower. No serious deficiencies were noted; and the towers were officially accepted by *CHESNAVFACENGCOM* on behalf of the Navy on 21 August 1977.

Subsequent to final government acceptance, *NAVAIRSYSCOM* arranged for application of the offshore instrumentation by Cubic Corporation. By mid-November, Navy pilots and pilots of other forces were flying combat training missions on a daily basis, weather permitting.

PROJECT ACCOMPLISHMENTS

Although construction of the *ACMR* towers was beset by various delays and a few problems, the project progressed more smoothly than anticipated. As a final result, the *ACMR* Tower Project was a success story - ahead of schedule, within budget, and completed with quality construction and without a serious mishap.

The remainder of this report details *CHESNAVFACENGCOM's* unique contracting experience with the offshore industry. The planning, design and construction efforts, and the occurring problems and their solutions are discussed. It is intended to initiate a basis for government contracting for heavy construction in the ocean realm.

SECTION II

DESIGN AND PLANNING

BACKGROUND

During 1974 and 1975, the Ocean Engineering and Construction Project Office (Code *FPO-1*) of the Chesapeake Division of the Naval Facilities Engineering Command (*CHESNAVFACENGCOM*) supported the Naval

Air Systems Command (*NAVAIRSYSCOM*) as technical advisors in the area of ocean engineering for the four ocean platforms for the East Coast Air Combat Maneuvering Range (*EC/ACMR*). *NAVAIRSYSCOM* contracted Cubic Corporation of San Diego, California, as their prime contractor for *EC/ACMR*. Cubic in turn, contracted Crest Engineering of Tulsa, Oklahoma to provide design, plans, and specifications for the four offshore towers. *CHESNAVFACENGCOM* contracted TERA, Inc., of Houston, Texas, to provide them engineering services in reviewing the Cubic/ Crest efforts. *FPO-1* provided the initial reference [1] performance specification for the *EC/ACMR* in its capacity as technical advisor.

In November 1975, the four ocean towers of the *EC/ACMR* were designated as a military construction (*MCON*) project for accomplishment by the Naval Facilities Engineering Command. *CHESNAVFACENGCOM* was designated in December 1975 as the responsible field division for this project. To utilize most efficiently the past engineering efforts, *NAVFACENGCOM* Headquarters provided *CHESNAVFACENGCOM* authority via reference [2] for sole source negotiations with Crest Engineering and TERA for their subsequent engineering services. *CHESNAVFACENGCOM* was also directed to accomplish the installation during the summer months of 1977 and within the *MCON* budget of $13 million.

With the requirements for a summer 1977 implant, it became obvious that a tight contracting and Government monitoring schedule needed to be developed. Very optimistically, this schedule required A & E completion of plans and specifications by October 1976, construction contract awarded by December 1976, procurement and fabrication completed by May-June 1977, and installation accomplished by mid-August 1977. The mid-August time was predicated by the short construction weather window of the offshore Cape Hatteras region from mid-May to mid-August. After mid-August weather historically deteriorates rapidly.

A&E DQA CONTRACTING

Table 1 provides a chronological summary of events with respect to the contracting of Crest Engineering and TERA for architect and engineering (A&E) and *DQA* services, respectively. The overall A & E and *DQA* efforts were divided into three phases: Phase A involved systems

TABLE 1 SUMMARY CHRONOLOGY OF A&E AND DQA CONTRACTS

CHRONOLOGY FOR CONTRACT NO. N62477-76-C-0179 WITH CREST ENGINEERING						
PHASES	SOW SENT TO CREST	FEE PROPOSAL DATED	INITIAL GCE	INITIAL FEE PROPOSAL	NEGOTIATED FEE	CONTRACT SIGNED
A ORIGINAL	DEC 75	JAN 76	$51,544	$119,578	$ 85,000	MAR 76
B MOD. P00001 MOD. P00004	? SETTLEMENT OF CREST CLAIM.	MAY 76	251,840	268,877 5,037.56	326,593 1,965	JUNE 76 ?
C MOD. P00002 MOD. P00003	DEC 76 UPWARD ADJUSTMENT OF UNIT PRICE ITEMS.	JAN 77	173,743	240,311 10,868	166,292 10,868	FEB 77 AUG 77
CHRONOLOGY FOR CONTRACT NO. N62477-75-C-0112 WITH TERA, INC.						
A MOD. P00002	FEB 76	FEB 76	45,969	40,400	21,200	MAR 77
B MOD. P00003	JUNE 76	JUNE 76	65,728	57,807.90	51,164	JULY 76
C MOD. P00004 MOD. P00005	JUNE 77 UPWARD ADJUSTMENT OF UNIT PRICE ITEMS.	JUNE 77	4,607	4,900 2,250	4,900 2,250	JUNE 77 AUG 77

analyses to establish environmental design criteria, costs, and an optimal configuration; Phase B involved design, plans, and specifications for the configuration selected during Phase A; and Phase C involved the construction quality assurance associated with the material procurement, fabrication, and installation of the four ocean towers and completion of *record drawings* from the *as-built* drawings.

This was Crest's first effort at contracting with the Government. Their inexperience and non-familiarity with the General Provisions and the *design to* requirement of *MCON* contracts resulted in several interruptions and delays during the fact finding and negotiations for Phases A and B of the C-0179 contract. The liability clauses in particular constrained Crest from initially going to contract. Crest was familiar with the oil industry practice where the owner generally assumes the major liability for any tower failure and the A & E is

liable only up to his fee. However, Crest signed the Phase A contract after they realized they were not contractually committed to Phase B when the design and tower liability became applicable. They subsequently signed Phase B after the Government concurred with Crest's request that their liability insurance fee of greater than $100,000 be included in the negotiated fee.

Other issues that caused some delays during negotiations included non-familiarity with the Government's fixed price (lump sum) contracts for A & E services and the requirement for the Contractor to accept an audit by the Defense Contract Audit Agency (*DCAA*). The designer was used to the common oil industry practices of time/material or cost-plus-fixed-fee type contracts, and no auditing requirements. However, all issues did get resolved and contracts were awarded as noted in Table 1.

Contracting with TERA for *DQA* services for this *MCON* project posed little problem. TERA was familiar with Government contracting and their involvement during the *MCON* phase of this project was contracted through modifications to their existing pre-*MCON* contract with *CHESNAVFACENGCOM.*

PERFORMANCE CRITERIA

NAVAIRSYSCOM required a 20-year operating life for the ocean towers. Tower performance criteria in sea state 7 (nominal 40 foot wave) and winds of 60 miles per hour included: (1) horizontal excursions of elevation 75 feet above mean low water of less than ± 1 foot and ± 1 degree of rotation, and (2) maximum rotation in the vertical plane of ± 1 degree. Other detailed criteria are stated in the A & E's scope of work.

PRE-MCON DESIGN

Sub-bottom profile and side scan sonar data were successfully taken in the fall of 1974 and did not reveal any unexpected geologic anomalies in the site area. However, initial attempts to obtain soil and foundation data during the fall of 1974 were unsuccessful due to inclement weather that prevented the drill vessel from drilling effectively. Soil borings were discontinued after one 55 foot hole had been drilled.

Attempts were made to extrapolate soils data in depth from the 55 foot soil boring and sub-bottom profile data in lieu of obtaining additional soils and foundation data through comprehensive drilling, sampling, and testing.

The reasoning behind this attempt was the initial program plans which called for installing the ocean towers in the summer of 1975. Thus, it was decided to proceed with the design process prior to completion of soil and foundation investigations. The original design effort (May 1975) resulted in four-legged, jacket-type structures utilizing 30 inch diameter piles. Fortunately, *CHESNAVFAC-ENGCOM* strongly emphasized the need for a comprehensive soil and foundation investigation prior to going to contract for fabrication and installation.

This advice proved wise. Subsequent soils and pile driveability data which became available in September/October 1975 indicated that required penetrations of 300 feet were not obtainable with the 30 inch piles of the original design. A suggested modification with reduced main pile penetration was the addition of four skirt piles. However, the projected cost of the four legged towers with skirt piles exceeded the *OPN* budget for the towers. It was at this point that the ocean towers were considered and successfully designated for procurement under the *MCON* budget.

MCON-SYSTEM ANALYSIS

The system analysis phase involved reassessment of the overall project on the basis of questions raised during the pre-*MCON* reviews of the skirt pile design and additional knowledge acquired since project inception in 1974. These reassessments resulted in the establishment of an environmental criteria applicable individually to each of the four sites; an optimal configuration based on cost and construction feasibility; and a plan to meet the *MCON* construction *design-to* criteria and summer 1977 implant. The following paragraphs summarize the highlights of the system analysis phase. References [3], [4], and [5] contain details of the investigations.

The pre-*MCON* environmental criteria had been determined from

available data within the Navy data bank. Questions were raised on the applicability of a singular wave height at all four sites and on the magnitude of the total tides. The A & E was tasked to provide a more comprehensive environmental description and, therefore, subcontracted to A. H. Glenn for the detailed information on the wave, current, tide, and wind environment at the four sites. The information is contained in reference [4]. Table 2 summarizes the final environmental design criteria used for the four sites for a 50-year storm recurrence interval. The basis for choosing a 50-year recurrence interval was that this interval was common in offshore practice for similar structures [1].

TABLE 2 EC/ACMR OCEAN STRUCTURES PERTINENT DESIGN STATISTICS

ENVIRONMENT (50 YR., STORM, WIND, & TIDE)

	TOWER WATER DEPTHS		
	81	93	105 FT (MLW)
ASTRO & STORM TIDE	8.5	8.1	7.7 FT
MAX. WAVE HEIGHT	60.3	60.8	61.3 FT
PERIOD OF MAX. WAVE	13.6	13.6	13.6 SEC
LENGTH OF MAX. WAVE	774.9	783.5	779.7 FT
1 MINUTE WIND	145	145	145 MPH
CURRENT: SURFACE	4.3	4.5	4.7 FPS
90% OF DEPTH	1.6	1.6	1.5 FPS

STRUCTURE

	PLATFORM			
	1	2	3	4
TONNAGE: SUPERSTRUCTURE	66	66	66	66
TEMPLATE	167	195	206	206
PILES	386	510	518	567*

*EXCLUDES 225T OF INSERT PILING

Several methodologies were available for the analytical representation of the design wave and its coupling with the design current. Three wave theories were compared: (1) Stoke's 5th, (2) A. H. Glenn, and (3) stream function. The Stoke's 5th and stream function are both from classical hydrodynamics and A. H. Glenn is a proprietory theory used by the oceanographer of the same name. Of these three, the stream function approach was selected for use in design because it provided the best representation of the nonlinear design wave.

Three wave-current coupling techniques were evaluated: (1) constant volumetric or constant Q, (2) riding wave, piggyback, or translating coordinate, and (3) stream function or direct. The stream function technique was selected since it provided the best fit to the dynamic free surface boundary condition while also satisfying the requirements of conservation of mass and vorticity. It also provided the worst case loading condition for design purposes.

Dr. R. Dean, a recognized oceanographer from the University of Delaware and subcontracted by TERA, Inc., provided the supporting information for the stream function approaches. Dean also presented a *free-surface effect* correction technique which is presently being used by the offshore oil industry and essentially distributes the horizontal loading such that the pressure curves will go to zero above the water surface and provide a maximum set distance below the free surface. The *free-surface effect* technique was selected for use in design because it provides a better correlation between the measured forces and theory.

In conclusion, the stream function wave theory and wave-current coupling method were selected for use in the design phase for determining the environmental loading from wave and current. The *free-surface effect* correction was also incorporated into the subsequent pressure profile representation. The complete rationale for these selections are well documented in reference [5].

Since the skirt pile configuration was essentially an expedient solution for the difficult soil conditions, this configuration was not considered an *a priori* optimal cost solution. A configuration/cost tradeoff study was therefore performed to seek an optimal solution. For uniformity of conditions for this tradeoff effort, the following pre-*MCON* environmental design conditions were imposed:

Water Depth	84 ft MLW
Total Tides	14 ft
Maximum Wave	62 ft high with 12 sec period
Current	5.4 fps (uniform)
Wind	150 knot
Wave Theory	Stokes 5th with $C_D = 0.6$
Installation	Summer 1977

A four-pile structure was compared with the four-pile with skirt-piles configuration and a three-pile configuration. Other configurations such as gravity and caissons had been considered and eliminated during the pre-*MCON* effort as permitting too much deflection; they were not restudied.

The tradeoff study established the three-pile jacketed structure as the optimal configuration on the basis of cost. The comparative estimated costs for three-pile, four-pile, and four-pile with skirt-pile configurations were $7.8M, $9.6M, and $12.9M, respectively. The three-piled structure was also considered installable by summer 1977.

Several other structural issues were also resolved in the system analysis phase. The superstructure dimension of an equilateral triangle with 29 foot spacing between 30-inch diameter legs down to an elevation of +16.5 feet MLW and jacket legs at a true batter of 1:6 were agreed upon for design. A pile size of 42-inch diameter was selected to accommodate a 300,000 foot-pound hammer. This selection of pile size and hammer was anticipated to provide improved driveability and reduce penetrations with a resultant reduction in installation cost. The 42-inch diameter pile also provided adequate inside clearance to permit the use of insert piles, if necessary.

MCON-DESIGN

The Phase B portion of this *MCON* project involved the design of the three-legged structural configuration and provided plans and specifications (*P&S*). Detailed information on the design aspects and *P&S* are contained in references [6], [7], and [8]. Technical highlights of this effort are presented below. Common offshore practice, such as that given in reference [9], American Petroleum Institute document (API-RP2A), and appropriate NAVFAC design manuals were to be used as design guides.

Figure 5, taken from reference [8], provides a three-dimensional view of the final configuration for the four towers with notation of the nominal elevation of the bracing level. For summary purposes, the towers consisted of a superstructure, a jacket, and piling driven through the legs of the jacket. Member sizes are detailed in reference [7]. Table 2 lists the tonnages of required steel for each tower and

Table 3 provides the resultant design compression and tension loads for the piling at each site and the associated required penetrations for a factor of safety of 1.5 [1].

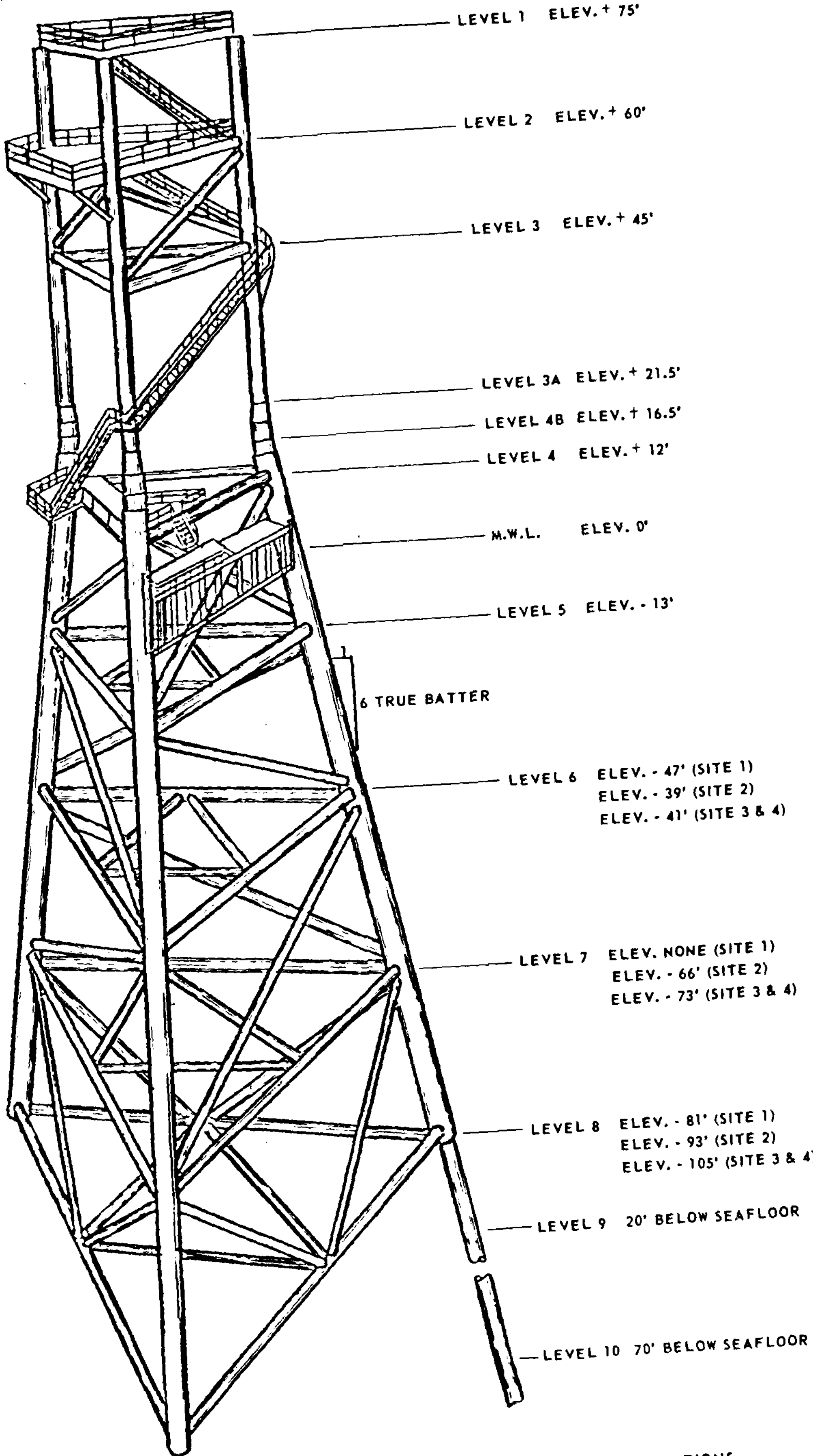
TABLE 3 EC/ACMR PILING LOADS AND REQUIRED PENETRATION

PLATFORM NO.	COMPRESSION	TENSION	REQUIRED PENETRATION BELOW MUDLINE (F.S. 1.5)
1	2552 KIPS	1884 KIPS	220 FEET
2	2926 KIPS	2006 KIPS	275 FEET
3	2931 KIPS	2010 KIPS	240 FEET
4	2957 KIPS	1984 KIPS	270 FEET

Prior to arriving at the final member sizing, material selection, and plans and specifications, several issues were resolved during the design phase. Notable ones involved the consideration given to biofouling, low environmental temperature, fatigue, earthquake, and potentially difficult pile driving during the design process.

During system analysis, coefficients of drag and inertia of 0.74 and 1.34 respectively were accepted for use in wave-current pressure curves to be provided by the stream function methodology. An assessment of potential biofouling via review of conditions at Argus Island tower, formerly in Bermuda; Diamond Shoal Light Tower at Cape Hatteras; and the literature revealed biofouling to be a definite concern. Therefore, the effective outside radius of the members was increased by 1 inch and the coefficient of drag was increased to 1.02 for load determinations from mean low water down to the mudline.

Potentially low environmental temperatures of air of 15° F and water of 35° F resulted in a concern for brittleness of common ASTM A-36 steel which was planned for overall use on the three-legged configuration. Consultation with Mr. T. Dawson, material consultant at *NAVFACENGCOM*, and with metallurgists at various steel companies, as well as independent queries by the A & E and *DQA* to other sources, resulted in steel material designations requiring fine grained ASTM A-36 steel with minimal Charpy-V values of 12.5 foot-pounds for all primary structural members. This modification provided material of



STRUCTURAL CONFIGURATION AND TYPICAL MEMBER AND JOINT DESIGNATIONS

FIGURE 5

ductility adequate to survive the expected temperatures for the cyclic loads considered. Higher grade steels (ASTM A633 and/or API-2H) were subsequently required at the joint cans to accommodate greater design stresses.

Since offshore platform design experience off Kitty Hawk, N. C., was nil in comparison to the experience available for comparative design in either the Gulf of Mexico or the North Sea, a comprehensive cumulative fatigue analysis was performed on the *EC/ACMR* towers. The API-RP2A provides nominal brace stress requirements for environments similar to the Gulf of Mexico. For environments more severe, it recommends the cumulative fatigue damage analysis approach used in the *EC/ACMR*.

Reference [4] provided the wave spectrum for an average 20 year period, the design life of the structure. The AWS D 1.1, reference [11], allowable stress-range vs cycles X-curve was used in conjunction with Palmgren-Miner cumulative damage rule to assess the fatigue life. Initial checks by *DQA* showed a couple of the bottom joints to have less than 20 year life. By increasing the wall thickness of these joints, the design resulted in all joints and members having fatigue life in excess of 20 years.

A major concern was how to achieve the pile penetrations required by the design. The soil and foundation analysis contained in references [12], [13], and [14] resulted in the required penetrations of 240 to 270 feet below the mudline as shown in Table 3 for the 42 inch piles for a factor of safety 1.5. The soils at each site generally consisted of 100 plus feet of very dense fine sand underlaid by thick stratifications alternating between very stiff silty clays and very dense silty sands. Wave equation analysis in conjunction with the maximum soil resistance curves indicated potential driving problems. Consultation between representatives of *CHESNAVFACENGCOM*, Crest Engineering, and TERA as well as individual consultations with oil industry personnel resulted in several steps to enhance driveability. These included the requirement for inclusion of a 300,000 foot-pound hammer in the contractor's suite of hammers and the use of uniform wall thickness of 2 inches to enhance pile stiffness and driveability at towers

#2, #3, and #4 where penetrations were greatest. (Tower #1 piles were of thickness varying between 2 and 1.5 inches.) Other innovations incorporated in the *P&S* to assure achievement of design penetration included:

(1) the use of a 2-foot driving shoe at the pile tip with a beveled point and an increased wall thickness. This would result in a soil plug of less diameter than the pile I.D.; thus, internal friction between the soil plug and pile wall would be reduced;

(2) the removal of the internal soil core if pile refusal occurred by either jetting or drilling to within 10 feet of the pile tip to essentially eliminate internal friction;

(3) the preselection of add-on lengths to assure that add-ons did not end in dense sand layers, thus minimizing detrimental effects of setup in clays and end bearing in sand;

(4) the acceptance of pile penetration at less than design depth if: (a) near-penetration can be achieved by normal driving; (b) refusal occurs with the pile tip in sand; and (c) the pile capacities provide a factor of safety of 1.35;

(5) the inclusion of 33-inch diameter of 1-inch wall insert piles for tower #4; this was a contingency in case the 42 inch main piles would not advance even after removal of the soil plug.

Refusal for penetrations not within twenty feet of design depth was defined as the point when driving resistance exceeded 500 BPF for five consecutive feet. A check of experience elsewhere in the offshore industry indicated that the 500 BPF was not unreasonable. Refusal for penetrations within twenty feet of design depth was defined in accordance with API-RP2A.

Even these measures did not eliminate the potential construction contractors' concern since the initial bid opening resulted in qualifications that design penetrations may not be achievable. Subsequent revisions to the *P&S* included provisions for (1) the removal of the

soil plug to within one foot of the pile tip, and (2) controlled predrilling ahead of the pile tip if plug removal failed to overcome refusal. These changes did not compromise pile capacity and factor of safety. In addition, driving refusal was redefined as the point when driving exceeded 2500 blows within a distance of five feet and with the last foot in excess of 500 blows; or 500 blows in six inches. This definition provided enough blowcounts to overcome reasonable pile setup and still not cause damage to the hammer.

MCON - WHAT IFS

Subsequent to the completion of the plans and specifications, consideration was given to situations that could arise and delay the smooth progress of the construction. *What-if* situations including loss of a tower during transport, foreign trawler interference with installation, too easy driving of piles, environmental pollution, and injuries to Government personnel were considered. Appendix A contains the *what-if* list and appropriate actions, if required.

SECTION III

CONSTRUCTION CONTRACTING

PREQUALIFICATION

During the spring of 1976, *CHESNAVFACENGCOM* determined that a market survey would be beneficial to ascertain the response the offshore construction industry might have to accepting the tight, less-than-one-year *ACMR* construction schedule. The market survey was also to serve as a vehicle to open communications between the Navy and industry to discuss both the completion schedule and pertinent construction and contractual issues.

CHESNAVFACENGCOM personnel contacted the majority of the offshore heavy-construction firms between 5 and 13 May 1976. The feedback was most startling. Industry was aware of past *ACMR* project delays; they anticipated additional long-term delays; thus, their

interest was cautious. Industry recognized that the Government would probably award any subsequent work on the basis of low-bid and not on the quality of *ACMR* construction; *ACMR* was a one-shot operation; thus, oil company customers who offered potential follow-up work were more appealing. It was the general impression that government contracting procedures were rigid and restrictive, and allowable profit margins were not worth the additional effort when other work was available. The attitude of most contractors was that if the Government expected to award a construction contract it would have to revise its fixed-price contracting procedures to be more like those of the industry where job risks were shared through cost-plus or unit-price contracts. In regard to risks, contractors were most concerned with the unknowns associated with *ACMR* pile driving and weather.

Although the results of the market survey were not encouraging, positive momentum with construction contractors had been established; to satisfy the construction target date of summer 1977, this momentum would have to be maintained. A prebid informational package which described the project requirements (approximate structure size and configuration, pile design penetrations, predicted environmental conditions) was assembled for distribution. Because of the schedule criticality and project importance, *CHESNAVFACENGCOM* considered it imperative that an experienced offshore contractor be awarded the construction contract; thus, a prequalification questionnaire was simultaneously assembled. Prequalification questions centered on the availability of a sufficient offshore derrick barge; the quantity and type of experience on offshore projects valued at $1.0M or more; bond potential; and man and machine resource availability.

Commerce Business Daily advertised the *ACMR* project in its 19 July 1976 issue. All interested contractors were requested to apply for a *Bidders Prequalification Data Package* consisting of the descriptive project information and the prequalification questionnaire. As indicated in Table 4, twenty firms requested the data package, eleven of which completed and submitted the prequalification forms by the 30 August deadline. During review of these submissions by a panel of *CHESNAVFACENGOM*

and *NAVFACENGCOM* personnel, it became apparent that several of the submitting firms did not have a genuine interest and/or available capability for the project. After several intensive review sessions in which they were telephoned and allowed to respond to panel questions, these firms withdrew themselves from consideration.

On 18 October 1976, the following firms were notified that they had prequalified for the *ACMR* Project:

Brown & Root, J. Ray McDermott, Morrison-Knudson,
Santa Fe, and Teledyne Movible.

TABLE 4 CBD RESPONSES AND SUBMITTALS

FIRM	REQUESTED PREQUAL FORM FROM CBD	RESPONDED WITH PREQUAL FORM	PREQUALIFIED OR WITHDREW
A. C. AUTERA, INC.	X		
BROWN & ROOT, INC.	X	X	PREQUAL'D
CANRON	X		
DELSEA PARKER CORP.	X		
R. W. DENNY, INC.	X		
ARNOLD M. DIAMOND, INC.	X		
GLOBAL MARINE DEVELOPMENT	X		
PETER KIEWIT SONS	X	X	WITHDREW
LOGAN ENGINEERING	X		
J. RAY McDERMOTT	X	X	PREQUAL'D
MORRISON-KNUDSON	X	X	PREQUAL'D
PERINI CORPORATION	X		
RAYMOND INTERNATIONAL	X	X	WITHDREW
SANTA FE ENGR. CO.	X	X	PREQUAL'D
SPEARIN, PRESTON, BURROWS	X	X	WITHDREW
TELEDYNE MOVIBLE	X	X	PREQUAL'D
TIDEWATER CONST.	X	X	WITHDREW
U. S. STEEL CORP.	X	X	WITHDREW
VERTEX SYSTEMS, INC.	X		
WILLIAMS-McWILLIAMS	X	X	WITHDREW

BID OPENING NO. 1

The Invitation for Bid, *IFB*, package was presented to the five prequalified contractors on 21 October 1976; bids were due by 29 November. The bid form included a lump-sum bid for all work except pile driving and weather hours, and unit price bids for footage of main and insert piling, and weather hours. A copy of the specification section governing weather hours payments appears in Appendix B.

Highlight of the bidding period was the Pre-Bid Conference held on 4 November. All of the prequalified contractors but Teledyne Movible sent representatives. The purpose of the conference was to respond to contractor questions concerning the plans and specifications and bid form. In accordance with ASPR guidelines to disseminate information in an equitable fashion, questions were submitted in writing by each contractor and answers read to the combined group. Government replies were strictly limited to questions asked. Contractors sought additional clarification of contractor liabilities, material requirements and substitutions, weather payment considerations, pile driving scenarios, and installation techniques.

As a direct result of the pre-bid conference, CHESNAVFACENGCOM upon recommendation of the A & E substituted Charply V-Notch test requirements in place of nil-ductility transition temperatures for all carbon steels and welding procedure qualifications. Both Charpy V-Notch values and nil-ductility temperatures are indicative of the steel and weld metal's resistance to brittle fracture, particularly in a cold water environment. Charpy V-Notch tests are generally more common, somewhat less time consuming, and thus were felt to have less impact on the already tight construction schedule. As a result of this modification (solicitation modification #0003) the bid opening date was postponed one week until 6 December 1976.

It is suspected that the contractors left the Pre-Bid Conference somewhat surprised at the apparent inflexibility of the client - in this case the Government. Contractors were used to negotiating the terms and conditions of their contracts. It is doubtful that the contractors appreciated the necessary, but seemingly abrupt and non-negotiable answers to their questions, i.e., "that is spelled out in the specification". The net result was that when the bids were opened on 6 December, only two contractors offered tenders, see Table 5; both bids were accompanied by pages of qualifying statements clarifying their interpretations of the specifications and limiting their liabilities and responsibilities. Many of their interpretations were not within the intent of the specifications. Thus, no contract could be awarded.

BID OPENING NO. 2

During the period 7 to 26 December, the bid package was reevaluated. Representatives of both Brown & Root and Santa Fe attended private meetings with *CHESNAVFACENGCOM* personnel to discuss relevant contractual issues across the negotiating table.

A major point of discussion concerned the driveability of the main piling. Both contractors believed that driving would be extremely difficult, and probably not possible, by conventional methods; remedial measures such as drilling pilot holes, plug removal or jetting would be necessary. The Government opinion was that *in all probability* the main piles would reach grade without remedial measures. The contractors countered with "fine, then the Government can assume the associated risk by establishing a day-rate similar to that for weather standby". Other issues of concern included the audit rights of the Government, warranties, and a satisfactory procedure for timely Government inspection and acceptance.

As a result of these meetings, the bid specification was significantly altered (see bid modification No. 4) and included a unit price provision for remedial work hours, revision of the Warranty Clause, and further clarified weather standby conditions.

All five prequalified contractors were allowed two weeks to reevaluate the revised bid package. At the bid opening on 11 January, again only two contractors submitted tenders. The bids are shown in Table 6. The fact that they are far apart reflects the differences in the two contractor's risk assessment - a risk not only associated with industry and environment factors, but also the risks of dealing with an *unknown* client.

Although the low bid exceeded the government cost estimate, the *ACMR* tower construction contract was awarded to Brown & Root Marine Operators, Inc., on 13 January 1977 for $12,494,135.00. The contract completion date was 19 September 1977.

TABLE 5 RESULTS OF BID OPENING NO. 1

BID ITEM	GOV'T COST EST.	BROWN & ROOT	SANTA FE
1(A)	\$ 9,725,292	\$ 7,345,000	\$ 7,473,400
(B)	\$ 635,667	(1)	\$ 3,470,540
(C)	\$ 272,259	(2)	(2)
(D)	\$ 544,518	\$ 780,000	(3)
TOTAL PRICE BID ITEM 1	\$11,178,736	(2)	(2)

NOTES: (1) PRICE INCLUDED IN ITEM 1(A) AS LUMP SUM
(2) UNSPECIFIED; BID PRICE QUALIFIED BY LIMITING STATEMENTS
(3) UNSPECIFIED; APPROX \$3,500/HR FOR ESTIMATED 302 HOURS

DEFINITIONS: ITEM 1 (A) PRICE FOR ALL WORK EXCEPT PILE DRIVING AND WEATHER HOURS
(B) PRICE PER LINEAR FOOT FOR MAIN PILE: (4350 FEET ESTIMATED)
(C) PRICE PER LINEAR FOOT FOR INSERT PILE: (1235 FEET ESTIMATED)
(D) PRICE PER HOUR FOR WEATHER HOURS: (312 ESTIMATED)

EVALUATION OF BIDS - AWARD WAS TO BE MADE TO THE BIDDER OFFERING THE LOWEST TOTAL BID FOR THE TOTAL BID ITEM 1.

TABLE 6 RESULTS OF BID OPENING NO. 2

BID ITEM	GOV'T COST EST.	BROWN & ROOT	SANTA FE
1(A)	\$ 8,411,336	\$ 9,300,135	\$23,648,220
(B)	\$ 857,750	\$ 1,309,500	\$ 3,781,985
(C)	\$ 1,000,750	\$ 1,104,500	\$ 1,452,500
(D)	\$ 756,600	\$ 780,000	\$ 1,034,280
TOTAL PRICE BID ITEM 1	\$11,026,436	\$12,494,135	\$29,916,985

DEFINITIONS: BID ITEMS
ITEM 1 (A) PRICE FOR ALL MATERIALS, WORK AND SERVICES EXCEPT NORMAL PILE INSTALLATION, REMEDIAL WORK HOURS, AND WEATHER HOURS
(B) PRICE PER LINEAR FOOT FOR NORMAL INSTALLATION OF 42" MAIN PILES (4365 FEET ESTIMATED)
(C) PRICE PER HOUR FOR REMEDIAL WORK:
(C-1) MAIN AND INSERT PILE INSTALLATION (245 ESTIMATED HOURS)
(C-2) DRILLING OPERATIONS (170 ESTIMATED HOURS)
TOTAL: (C-1) + (C-2)
(D) PRICE PER HOUR FOR WEATHER HOURS (312 ESTIMATED)

EVALUATION OF BIDS - AWARD WAS TO BE MADE TO THE BIDDER OFFERING THE LOWEST TOTAL BID FOR THE TOTAL BID ITEM 1.

SECTION IV

FABRICATION

AWARD

The contract for fabrication, transportation, and installation of the four *ACMR* towers was awarded to Brown & Root Marine Operators, Inc., on 14 January 1977 with a completion date of 19 September - just over eight months away. Again, this tight construction schedule was required to complete installation of all four towers before the close of the weather window and advent of the September hurricane season, common to the Cape Hatteras region.

On 18 January, key project-designated personnel from Brown & Root attended a pre-construction conference at *CHESNAVFACENGCOM*. Contractor representatives included a company vice-president, the chief estimator, the offshore operations manager, and the project manager and project engineer. Representatives from *CHESNAVFACENGCOM* Codes 02, 04, 05, 09A, and *FPO-1* briefed contractor personnel on key issues such as contract submissions, *CQC*, safety, contractor invoice, Government inspection, and other contractual requirements and procedures. Both the Resident Officer in Charge of Construction, LT R. Mayer, and his Assistant Resident Engineer in Charge of Construction, Mr. A. W. Brill, were introduced, and the *ROICC*-staff chain of command and contractor interface were explained. The conference established, what would prove to be, effective lines of communication between both parties.

The contractor indicated that he intended to fabricate the components of the four towers at his Green's Bayou facility on the Houston Ship Channel. Shortly after the pre-construction conference, Brown & Root submitted its initial construction schedule. This schedule planned for initiating fabrication the third week in February after five weeks of material take-off and procurement. The objective was to meet a May 16 sailing date for towers #2 and #3, and have towers #1 and #4 ready for transportation by 23 May.

MATERIAL PROCUREMENT

Brown & Root project management realized soon after contract award, if not earlier, that procurement of special steel to satisfy the fracture toughness requirements of Specification Section 05120, para. 5.3.2, would be difficult; i.e.

> "Additional Requirements: ..., carbon steel for primary structure shall:
>
> (a) Have a yield point not exceeding 55,000 pounds per square inch and have a ratio of yield strength to ultimate strength not exceeding 0.85;
>
> (b) Have Charpy-V Notch test results equal to the low energy specimen values of Table A1 of ASTM E-23...(i.e. 12.5 ft-lbs at 10° F);
>
> (c) Exhibit sufficient weldability ..."

ARMCO steel, the yard's chief supplier, indicated that it could provide satisfactory API-2H and A-36 fine grain (FG) steel plate but not within the project manager's 4-week time estimate. The cold winter of 76-77 had taken its toll on energy resources; steel production had been significantly curtailed; and huge customer backlogs were only now being supplied. Even though Brown & Root was a steady and important customer, the quantity of material involved just did not justify specialized material runs without significant funding compensation. Rather, delivery of the plate would have to be accepted over a 6-10 week time span. Both contractor and government interface with other major steel suppliers indicated that industry backlogs were the norm nationwide, and ARMCO's delivery schedule was the best to be expected. Brown & Root did not desire to incur the additional expense of special manufacture; instead, it decided to slip the project schedule 3-4 weeks to accommodate delivery.

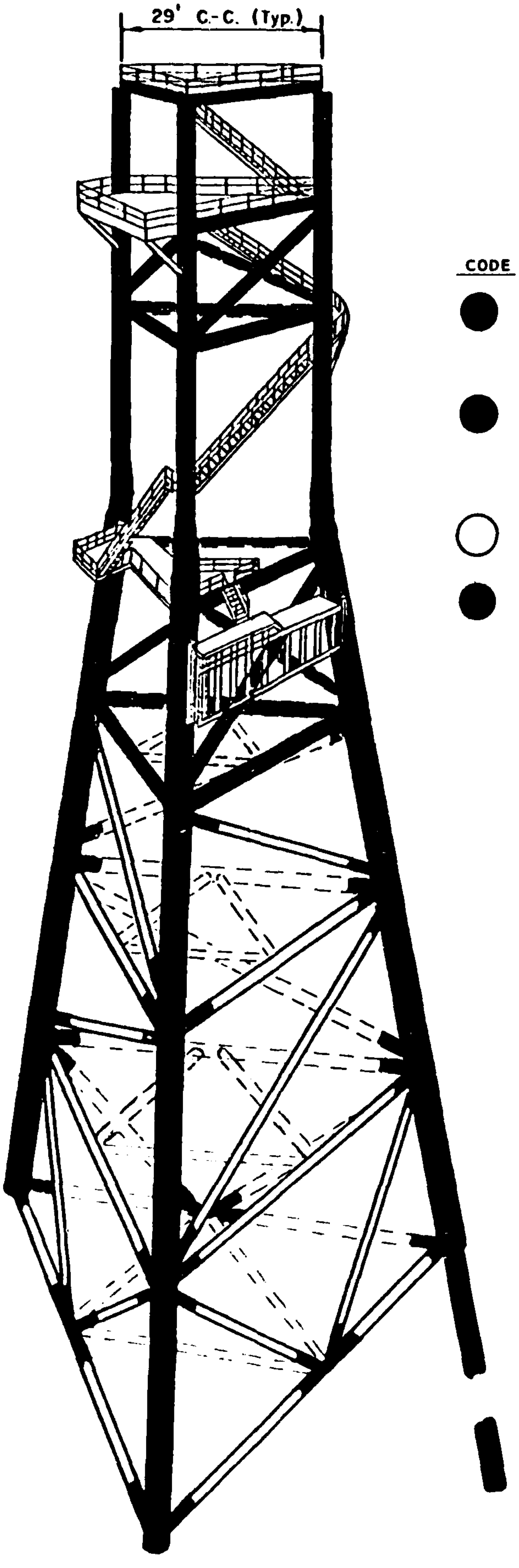
Procurement of the fracture-tough brace members brought forth other problems. Because of the many combinations of diameters, thicknesses, and lengths, and small quantities of each, delivery of pipe could not be expected for 8 weeks or more. Fabrication of the various sizes from plate would strain operations in the contractor's pipe facility because of the need to frequently change the bars of the

rolling presses to accommodate different sizes. Ideally, the brace members could have been procured as steel pipe, except that pipe off-the-shelf rarely came with specified Charpy-V values. Thus, Brown & Root requested that the government waive the fracture-toughness requirement of the brace members. A first reaction to such a request might have been "you bid the job; you resolve your own problems"; however, in the interest of job progress and success, *CHESNAVFACENGCOM* agreed to task its A & E to reevaluate brace member requirements.

Based upon a review of the fatigue stresses under design load and the air and water temperatures, *CHESNAVFACENGCOM*, upon recommendation of the A & E, insisted that all primary bracing members at or above *minus* thirteen feet MLW elevation, and all stub ends of primary bracing members below this level, meet the Charpy requirement. However, waiver of the Charpy requirement for intermediate portions (between stub ends) of primary bracing members below *minus* thirteen feet MLW was granted. A diagram of the required material properties within the structure appears in Figure 6.

This waiver of material properties was approved without the government seeking monetary compensation in the interest of job progress, and government-contractor relations. The contractor had already corrected numerous detailing errors which he had discovered while preparing structural member spool sheets. This waiver agreement was considered by the *ROICC* staff as one of its most significant decisions because it established a spirit of cooperation between both sides. The end result was that *not one* government-cost change order was required from fabrication through installation - all contract/specification discrepancies were resolved through no-cost field orders; and, more significantly, later offshore weather hour negotiations would be settled harmoniously, with little disagreement.

As a result of this final material decision, Brown & Root placed orders for all its steel plate with ARMCO steel, which had a steel production factory in close vicinity to the Green's Bayou fabrication yard. Procurement of the brace members was accomplished in different fashion. Members of Brown & Root's *CQC* staff would visit local pipe suppliers and remove samples from each available heat of appropriate size pipe.



CODE	MINIMUM MATERIAL REQUIREMENTS
●	API-2H STEEL
●	CARBON GRADE STEEL MEETING ADDITIONAL REQUIREMENTS OF SPECIFICATION SECTION 05120.5.3.2 (ASTM-A36FG OR EQUIVALENT)
○	CARBON GRADE STEEL - ASTM-A36, ASTM-A53 GRADE B OR EQUIVALENT
●	CARBON GRADE STEEL - ASTM-A572

MATERIAL REQUIREMENTS
FOR ACMR TOWER STRUCTURE

FIGURE 6

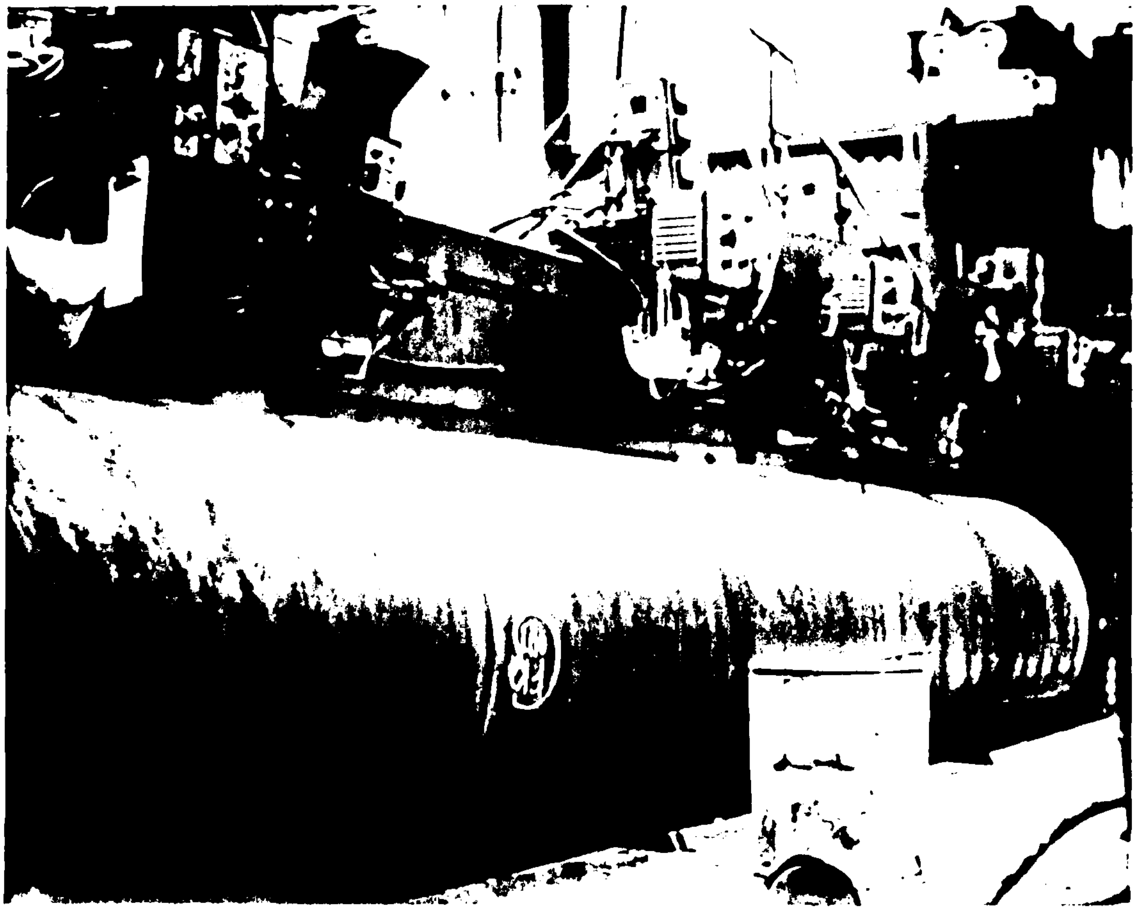
These samples were *rushed* to Brown & Root's Materials Laboratory for Charpy-testing. If the samples tested satisfactorily, Brown & Root would procure as much pipe from the identical heat as available or needed. Nearly one-hundred samples were tested, two or three heats failing for every one accepted. As an end result, the contractor was able to locate 70% of his required brace members. The remaining requirements were filled by using members of slightly different size (with government approval) or fabrication of the members entirely from steel plate.

PIPE MILL FABRICATION

By the third week in March, sufficient A-36-FG and API-2H steel plate had been received at Green's Bayou to begin member fabrication. All jacket legs, superstructure columns, and piles were formed from large sheets of steel plate. Initially, the plate would be cut into appropriate 5(±) foot lengths, beveled, and rolled into cans in the contractor's pipe mill. The short 5(±) foot lengths were then combined or spliced into their required lengths by submerged arc-welding techniques, Figure 7. All splices in legs, columns, and piling were 100% radiographically inspected, before being transported to the fabrication yard for assembly.

ASTM A-36 fine grain steel has a reduced grain size over that of conventional A-36 steel; and, as a result, has improved strength and resistance to brittle fracture and fatigue failure. As suggested in Section II, for this reason, it was expected to be better able to survive the harsh dynamic loadings and cool water temperatures of the Cape Hatteras region.

One problem surfaced when the *ROICC* staff exercised the government's inspection option. Samples of brace pipe rolled in the contractor's facility were tested for Charpy-V Notch toughness at an independent NDT laboratory. The resultant Charpy-values of certain of the samples had decreased substantially from that of the original plate (as indicated on certified mill certificates). Closer inspection revealed that these members were being rolled in cold form to the maximum extent possible; when they could not be closed to tubular shape by cold



SUBMERGED ARC WELDING OF JACKET COLUMNS

FIGURE 7

forming, they were then furnace-heated and finished by hot-forming. The inordinate degree of cold-forming was considered detrimental to the materials' Charpy properties.

The contractor's initial position was that he had purchased satisfactory steel plate and had rolled the plate in accordance with the contract specifications (API Spec 2B). He did feel responsible if these actions did not result in a desired end product. The [illegible] staff noted that API Spec 2B allows that pipe may be either hot-formed or cold-formed, [illegible] both.

Considering the D/T ratios and Charpy values of the plate remaining to be rolled and the results of the post-fabrication testing, the final resolution agreeable to both the contractor and the [illegible] was that

the remaining brace pipe with D/T ratios less than 20 would be entirely hot-formed at 1600° F. Subsequent testing of brace pipe formed by this technique showed no appreciable change from the Charpy values of the original plate.

FABRICATION YARD

While pipe mill activity was still underway, welders were busy outside fabricating the boat landings, barge fenders, and handrails from conventional steel pipe welding on the galvanic type anodes to available brace pipe, and fabricating the decks for each of the superstructures.

The superstructures were fabricated on their sides. One side (brace pipe) of each superstructure and the two decks were welded out between two columns; the remaining two sides were framed into the third column. The third column was subsequently lifted, rotated, and set down atop the other two columns and decks for weldout. The superstructures were then uprighted in a two-crane lift operation for installation of the jib cranes, stairways, solar panel frames, navigational aids (signal horn and lights), and final painting.

The jackets were fabricated in similar fashion in another section of the yard. One side of each jacket was welded out between two legs, and the remaining two sides were framed into the third leg. This third leg was then lifted, rotated, and set down atop the other two legs for weldout and painting. Only the top twenty (±) feet of each jacket was painted. The paint would provide added corrosion protection to an area of the jacket which would be required to survive in the highly corrosive tidal and splash zones of the sea.

All field welds connecting brace pipe to superstructure columns and jacket legs were magnetic particle and ultrasonically inspected upon completion of welding.

ROICC ACTIVITY

Prior to completing the plans and specifications, *CHESNAVFACENGCOM* recognized the need to maintain a *ROICC* field office at the contractor's yard throughout fabrication. The availability of an on-site

government representative would provide an avenue for immediate liaison with the contractor to keep abreast of design changes and to resolve fabrication problems. Thus, a requirement for 400 square feet of office space including office furniture and utilities was included in the contract specifications.

From the start of fabrication, the *ROICC* office was manned by the *ROICC* and/or the *AREICC* on a full-time basis. An on-site welding inspector and structural engineer under contract from the A & E were also available throughout fabrication to support the *ROICC*.

The *ROICC* staff performed surveillance of the fabrication process, job safety, and the contractor's testing and inspection procedures. Their activities also included review of contractor's quality control reports, conducting weekly project meetings with the contractor to discuss job progress, assessing and approving contractor invoices, performing independent government inspections (see pipe mill fabrication, above), and, most significantly, they were available to provide responsive answers and solutions to contractor questions and problems.

Brown & Root identified many structural detailing errors or omissions during fabrication. In each case, the government representative (*AREICC/ROICC*) was able to revise certain non-essential material requirements or structural changes, at the request of Brown & Root, in exchange for the contractor correcting the design deficiencies at no cost. For example, a *revised* wiring system for tower instrumentation and navigational aids was provided by the contractor by Field Order No. 7, in lieu of replacing several minor structural members fabricated out of specification, e.g. two pieces of structural pipe had circumferential welds within 8 feet of each other, instead of the code-required 10 feet. A total of eight no-cost field orders involving over 50 design modifications were processed during fabrication. The on-site A & E structural engineer provided for responsive concurrence (or otherwise) on behalf of the A & E of all design modifications.

In response to one of the *what-ifs* (see Appendix A), all government furnished equipment was unpacked, inspected for damage, tested, and repacked as necessary for shipment to sea. As a result of these precautions, numerous damaged solar panels were discovered in the fabrication

yard. The project manager and fabrication yard foreman initially attributed the damage to the shipper; until the *AREICC* discovered through discussions with other yard personnel that the yard's Material Receiving section had inspected the panels upon receipt and found no evidence of damage. The contractor then assumed responsibility for their replacement. Thus, the *ROICC* staff was able to avoid an unjustified government expense for replacement; and, more importantly, identified a problem for resolution, precluding its adverse effect on the critical offshore installation schedule.

In addition to *CHESNAVFACENGCOM's* technical, contractual, and supervisory support, the *ROICC* staff was also aided by the supply department at the Naval Air Station, Corpus Christi. Through their establishment of a petty cash account, the *ROICC* staff was able to contract for, and receive, essential material laboratory testing services on a two-day turn-around basis; as well as to procure needed construction inspection supplies (weld sticks, tape measures, etc.) not available in government supply. The *ROICC* staff also had access to a reproducing machine and telecopier provided by *CHESNAVFACENGCOM*, normal office supplies from *DCAS* Houston, and long distance telephone service from the contractor as a result of a provision in the contract.

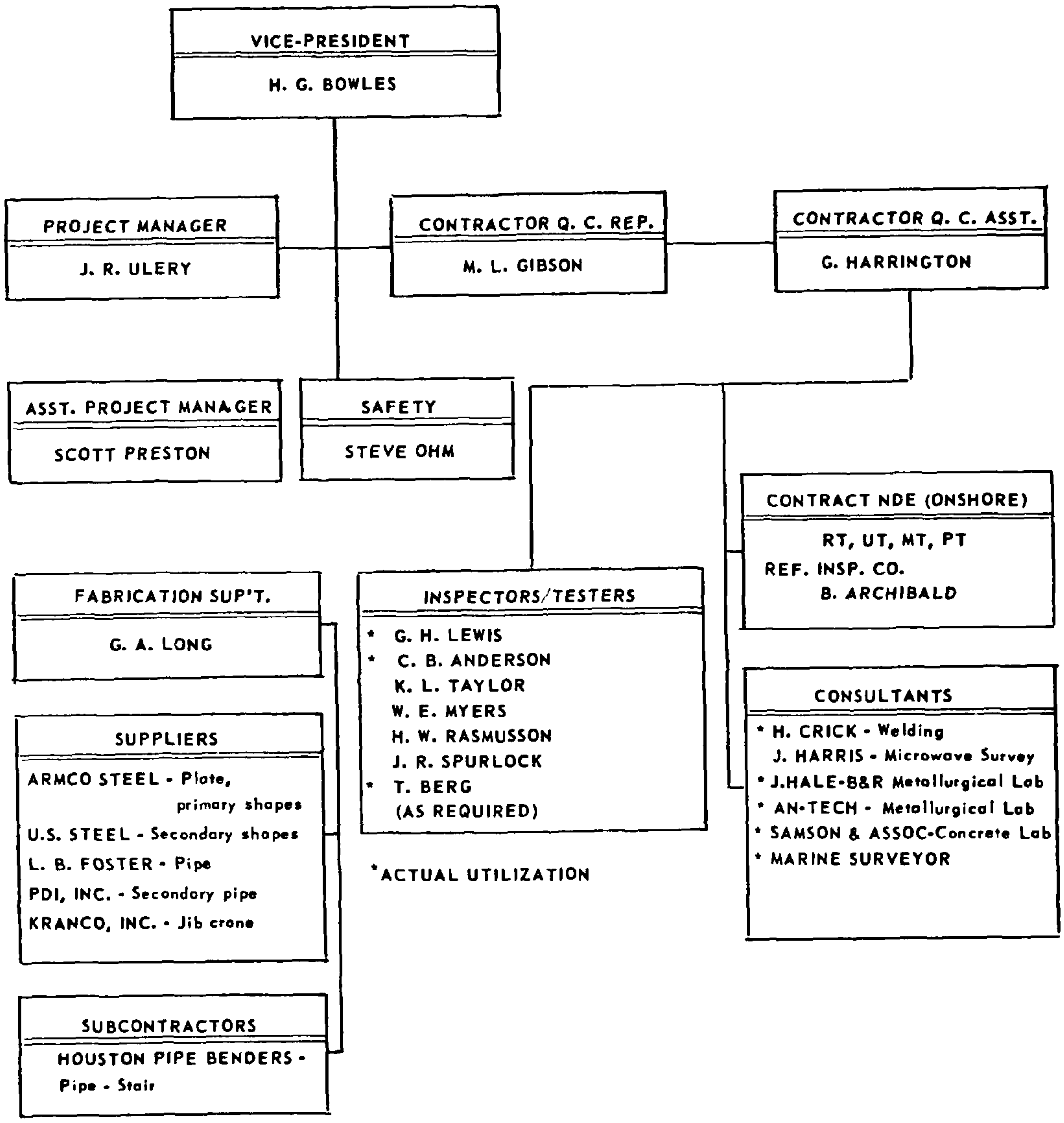
SAFETY

Maintenance of a Brown & Root safety program was included as part of daily procedures at the fabrication yard. This included safety displays, occasional site-visits by a safety supervisor, and occasional safety lectures by yard foremen. In accordance with contract provisions, the contractor appointed a project safety coordinator and submitted a formal safety plan.

There were no serious injuries during fabrication. This success is attributed more to the experience and conscientiousness of the working force than the formal safety program, however. The overall philosophy of the safety department was not to interface with operations unless absolutely necessary. On occasion, the *ROICC* staff had to advise the safety coordinator that safety violations were occurring, and that more strict safety enforcement was required.

CQC ORGANIZATION FOR ACMR TOWERS FABRICATION
BROWN & ROOT MARINE OPERATORS, INC., HOUSTON, TEXAS

FIGURE 8



CONTRACTOR QUALITY CONTROL

In accordance with the contract general provisions, the contractor was to establish a quality control organization (*CQC*) and formal plan to perform the necessary inspections and tests to ensure conformance with the contract provisions. The *CQC* organization and structure is shown in Figure 8. The primary duties of the *CQC* staff were to review contractor

spool sheets and erection drawings for conformance with the plans and specifications; to review material certifications and maintain material traceability; to inspect and verify that all welding procedures, welders, and welding operators were qualified for *ACMR* construction (see Specification Section 05121); to continually - throughout fabrication - inspect the quality of workmanship; and, through subcontract, to perform NDT of all material (visual and ultrasonics for laminations) and completed welds (visual, radiographic, ultrasonic and magnetic particle for weld defects).

By far, the most difficult and time consuming of *CQC* tasks was ensuring the traceability of material and weld records. For material, a color coding system was devised such that as material was received in the yard, it would be painted with an appropriate color to designate its property characteristics or type (i.e. API-2H; A36FG; etc.). A *master* color (purple) was also applied to differentiate *ACMR* material from other clients' material. As material was cut, rolled, and/or heated, *CQC* had to ensure that the color code system was maintained. They were generally effective.

Similarly, each circumferential splice (approximately 1000 total) in main structural members (piles, columns, legs, and interconnecting brace pipes) were inspected by radiography techniques. Each weld was number-coded to correspond with the X-ray sheet. Occasionally, the number-code on the structural member would be or become illegible due to handling, smearing, or paint covering. In these cases, the weld in question had to be re-inspected.

NDT inspections revealed a serious problem in fabrication of the brace members. The majority of stub ends of all jacket brace members were rolled from A36FG plate. However, each of these rolled specimens had some degree of out-of-roundness. When the stub ends and intermediate sections were welded, the misalignment of circumference caused weld run-through and the formation of *dingleberries* on the pipe's inside surface. Because of the two-dimensional aspect of the X-ray picture, these brace pipe welds were failing inspection at a greater than 50% rate. Had the pipe been of larger diameter, the contractor may have

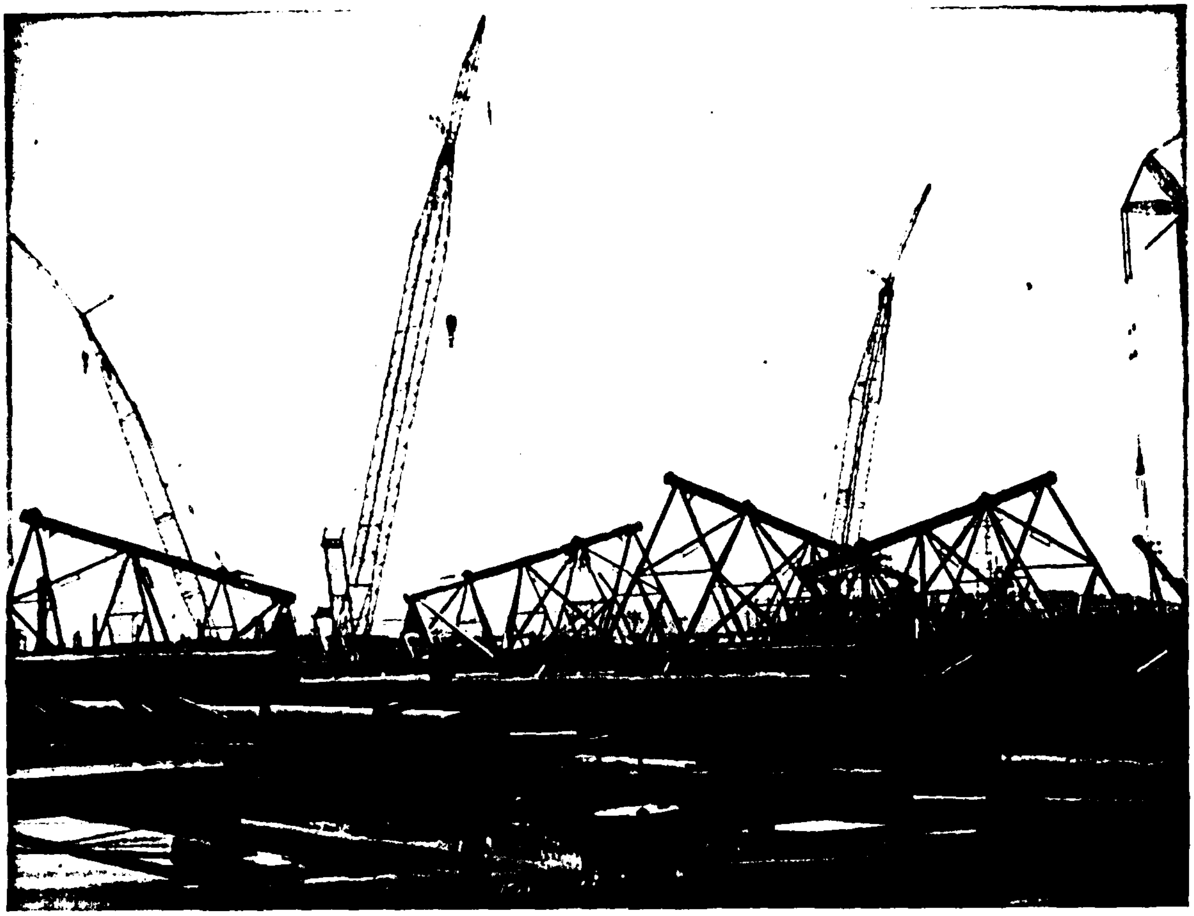
successfully removed the *dingleberries* by grinding. As it was, the contractor had to take much greater caution in his stub end rolling, brace pipe alignment, and first weld pass.

As part of the *CQC* effort, Brown & Root's offshore survey group performed a hydrographic survey at each of the four *EC/ACMR* sites to validate the Government Furnished Information (*GFI*). The overall bottom contours were similar to the *GFI*. However, actual water depths varied from one to four feet. Subsequent analyses by the A & E determined that these variations in water depths would not be detrimental to the structural integrity of the towers. Field Order #9 increased the installation depth tolerances to accommodate the depth differences. Fortunately, identification of the water depth variations, prior to going offshore, precluded possible costly installation delays.

Contractor quality control was marred by one event when the *CQC* representative was removed from the position by senior management personnel. A combination of personality conflict between the *CQC* representative and production foreman, and the former's apparent unreasonableness in *CQC* enforcement was given as the cause. The *ROICC* chose not to become involved in the issue since *CQC* continued on level par. The assistant *CQC* representative was appointed to fill the vacancy.

FABRICATION COMPLETED

The first jacket and superstructure (tower #2) were completed by mid-May, nine weeks after initiating fabrication. Because fabrication of each tower including piling was staggered and overlapped, fabrication of all four towers - involving over 3,000 tons of steel and 100,000 man-hours - was completed in twelve weeks, Figure 9. By the first week in June, the contractor was ready to take to sea.



JACKETS IN FABRICATION YARD

FIGURE 9

SECTION V

TRANSPORTATION

BACKGROUND

Transportation of the *ACMR* tower components and offshore construction equipment from the contractor's fabrication yard to the East Coast installation sites was accomplished in two phases. The first phase involved transportation of the derrick barge, the *H. A. LINDSAY*; and two cargo barges loaded with the components of towers #2 and #3, and auxiliary equipment for possible drilling and grouting of piles.

As the installation of tower #2 neared completion, the transportation plan called for a third barge with components of the remaining towers to be transported to site as Phase II.

LOADOUT: PHASE I

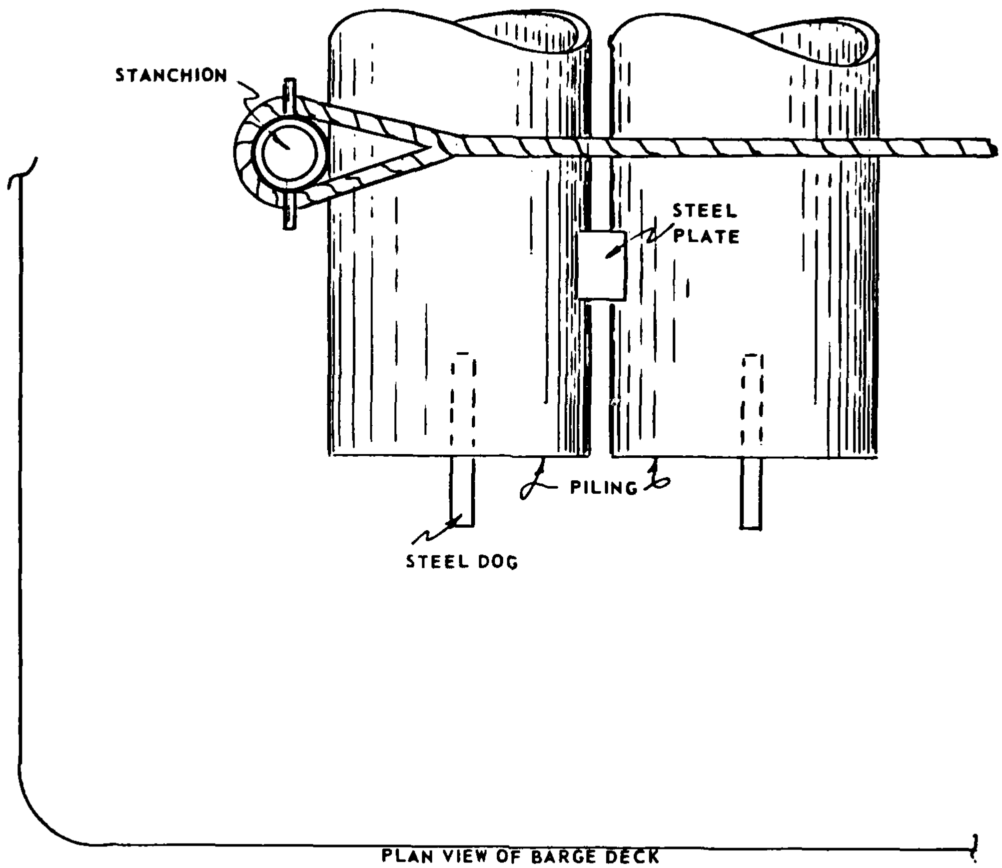
As required by the contract specifications, the contractor prepared a combined transportation/installation plan, (reference [15]). The transportation section of this plan included a shipping manifest for each barge (Appendix C), material loadout drawings, sea-fastening designs, calculations for trip-in-tow conditions, and barge and tug certifications for the intended vessels. Vessel statistics are presented in Table 7.

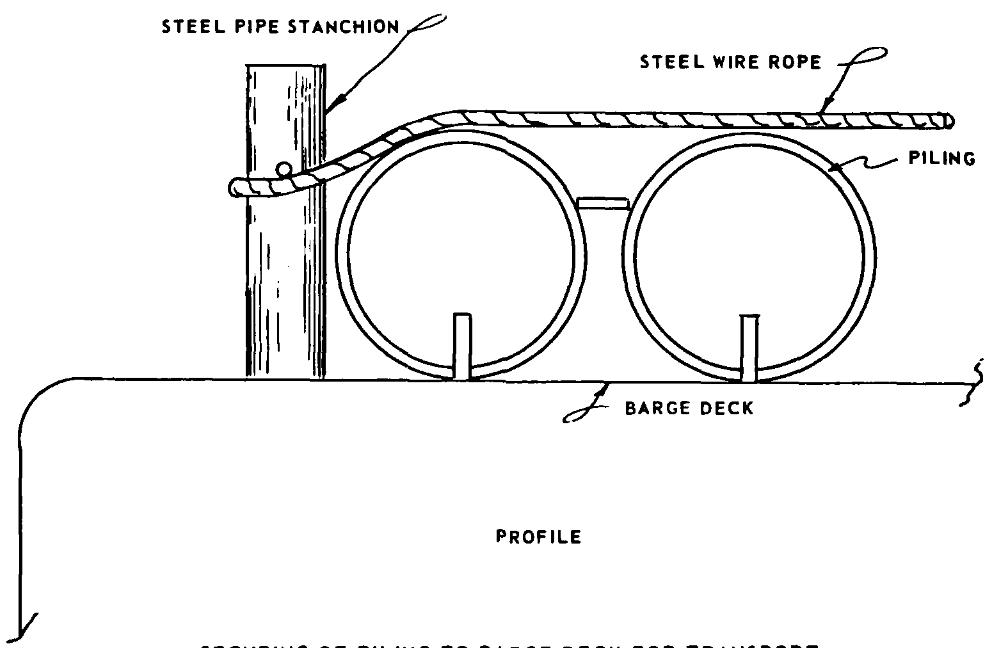
TABLE 7 TRANSPORTATION

BARGE	OWNER	DIMENSIONS	YEAR	ABS
H. A. LINDSAY	BROWN & ROOT	300' x 90' x 19'	1956	A-1
BAR-374	BROWN & ROOT	250' x 75' x 16'	1977	A-1
MM-262	BROWN & ROOT	250' x 75' x 16'	1965	A-1
MM-224	BROWN & ROOT	220' x 60' x 13.75'	1967	A-1

TUG	OWNER	HORSEPOWER	YEAR
MISTER DON	JACKSON MARINE	3400	1975
ROBBYN J	JACKSON MARINE	2550	1975
SIDNEY CANDIES	OTTO CANDIES	3600	1972
KEVIN S. CANDIES	OTTO CANDIES	4700	1967

By the first week in June, fabrication of the components of towers #2 and #3 had been completed and Phase I of transportation began. One-hundred ton mobile cranes were used to load the first cargo barge, *BAR-374*, with 777 tons of main piling. This quantity included the majority of main piling for towers #2, #3, and #4. The piling was placed longitudinally on the deck. Heavy-walled steel pipe stanchions were welded to the deck adjacent to the outboard rows of piling. Steel wire cables were passed across the top of the piling, around the stanchions, drawn tight and secured with wire rope clamps. In addition, the ends of each pile were secured to the deck with dogs, and adjacent piles were secured to each other by miscellaneously spaced steel plates welded to the piling across the interstices, see Figure 10. This





SECURING OF PILING TO BARGE DECK FOR TRANSPORT

FIGURE 10

technique of sea fastening was considered necessary to prevent movement of piling during the sea voyage.

Four mobile cranes worked in unison to walk each of the jackets for towers #2 and #3 from the fabrication area to pierside. One at a time, a 500-ton barge crane lifted each jacket from the pier, repositioned, and lowered them laterally onto six saddles staged on the deck of the *BAR-374*. The height of the saddles allowed the jackets to span the previously stowed piling. Where necessary, the positioning of the saddles was adjusted to receive the jacket while it was being lowered. The saddles were then welded to the deck. To secure the jackets in the saddles, diagonal *knee* braces were welded between the jackets and deck.

In a similar fashion, drilling and grouting equipment and materials, and the insert piling for tower #4 were loaded and secured on the deck of the cargo barge *MM-224*. A single mobile crane then carried each of the superstructures for towers #2 and #3 to pierside and positioned them vertically onto deck-reinforcing steel plates. Each leg of the superstructure was welded to its supporting plate. Additional sea fastenings consisting of *knee* braces (12.75 in. pipe) and wire rope were connected from each superstructure to the barge deck.

A marine surveyor from the United States Salvage Association, Inc., conducted an inspection of the tugs, towing bridles, and as-loaded barges. This inspection was to certify the integrity of the marine equipment and cargo for the 1700 mile ocean voyage. A sample surveyor's report can be found in Appendix D.

TRANSPORTATION: PHASE I

Although it had been specified as a contract requirement, the contractor obliged the government by allowing for a government representative to accompany the tow during each phase of transportation. Thus, LCDR G. Cullison as Resident Officer in Charge for *ACMR* transportation (*ROICC-T*) rode the tug tending *BAR-374* from the fabrication yard to its east coast destination. His responsibilities included surveillance of the tower components, albeit from some distance, and providing *CHESNAVFACENGCOM* with a daily point of contact for location and status of tow. His

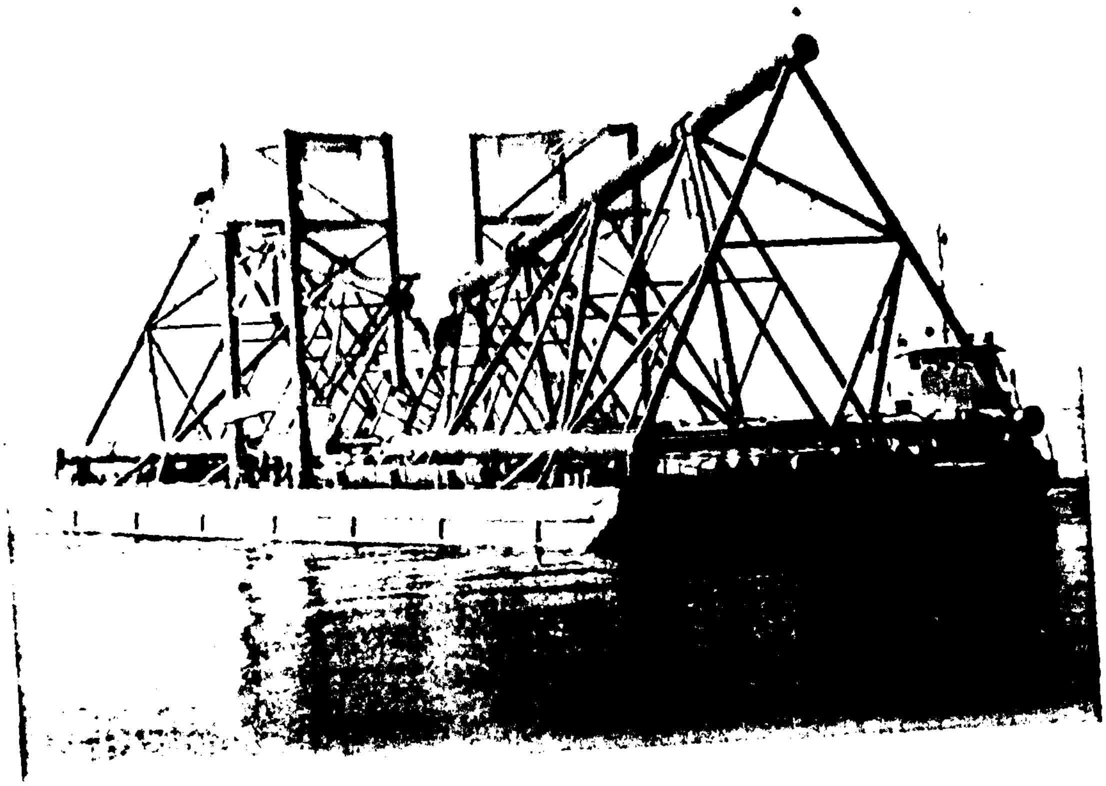
presence was considered necessary to evaluate and document potential weather delays experienced by the contractor for subsequent claim negotiations, and to ensure that the tug captain took appropriate precautionary measures in the event of an impending extreme situation (i.e. retreat to port; reroute to calmer waters; etc.).

On 10 June, the first tow was underway, down the Houston Ship Channel and into the Gulf of Mexico. The tugs *SIDNEY CANDIES* and *ROBBYN J* towed the cargo barges *BAR-374* and *MM-224*, respectively. The following day, the four-vessel convoy rendezvoused with the derrick barge *H. A. LINDSAY* under tow by the *MISTER DON*. The *LINDSAY* had just completed supporting another Brown & Root project in the Gulf.

While enroute to its east coast destination, the convoy encountered a severe electrical storm. The *ROICC-T* suspected - potentially - that lightning had contacted one of the tower jackets. Possible damage could only be surmised such as possible detrimental effect to material properties or damage to either the rubber closures at the base of each leg, or to the flood-control valves. Arriving at the installation site on 22 June, after an otherwise uneventful voyage, a visual inspection of each jacket was made. No visual evidence of any electrical discharge or damage was found.

The remaining components of towers #1 and #4 were loaded on a single barge, the *MM-262*. The two jackets were placed into saddles on each end of the barge, again so as to sit over previously stowed piling. The two superstructures were positioned vertically in the center of the barge, between the two jackets, Figure 11. All components and materials were securely fastened to the deck in a manner similar to that of Phase I. A marine surveyor certified the integrity of this barge, its cargo, and its attending tug, the *KEVIN S. CANDIES*.

With Mr. D. Masso from *CHESNAVFACENGCOM* as *ROICC-T* aboard the tug, the Phase II tow departed the farbication yard on 7 July 1977. Encountering only fair weather and following seas, the tow arrived at the installation site on 13 July. Installation of tower #3 was underway.



TOWERS #1 AND #4 ON BARGE MM-262 FIGURE 11

SECTION VI

INSTALLATION

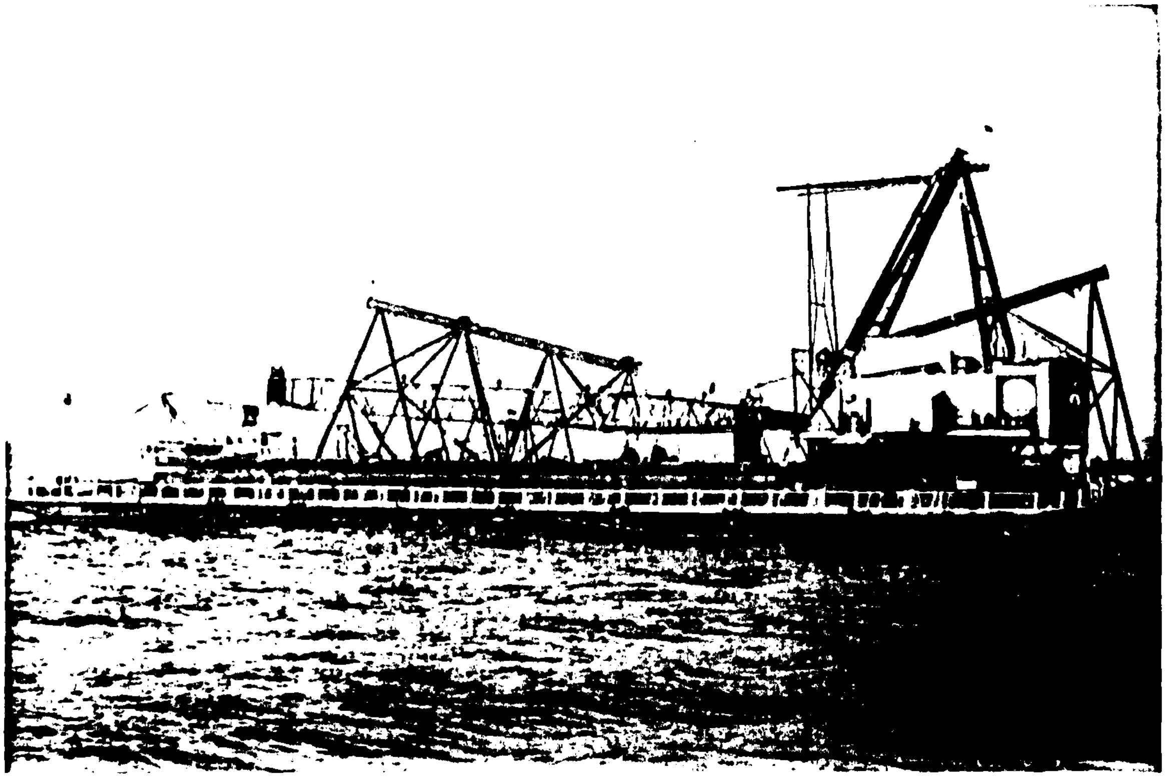
SEQUENCE OF OPERATIONS

The derrick barge *LINDSAY* and the two cargo barges with the components for towers #2 and #3 arrived offshore Kitty Hawk, N. C. on 21 June 1977, two full days ahead of schedule. The following day, an offshore survey crew placed a marker buoy at the designated location of tower #2. By the evening of 22 June, the *LINDSAY* had been placed in a six-point moor and rigged for work. To take maximum advantage of all

good weather, both night and day, the contractor's crew and the *ROICC* staff were divided into two twelve-hour shifts. Thus construction and construction surveillance would be continued on a 24-hour, seven-day-per-week basis throughout installation.

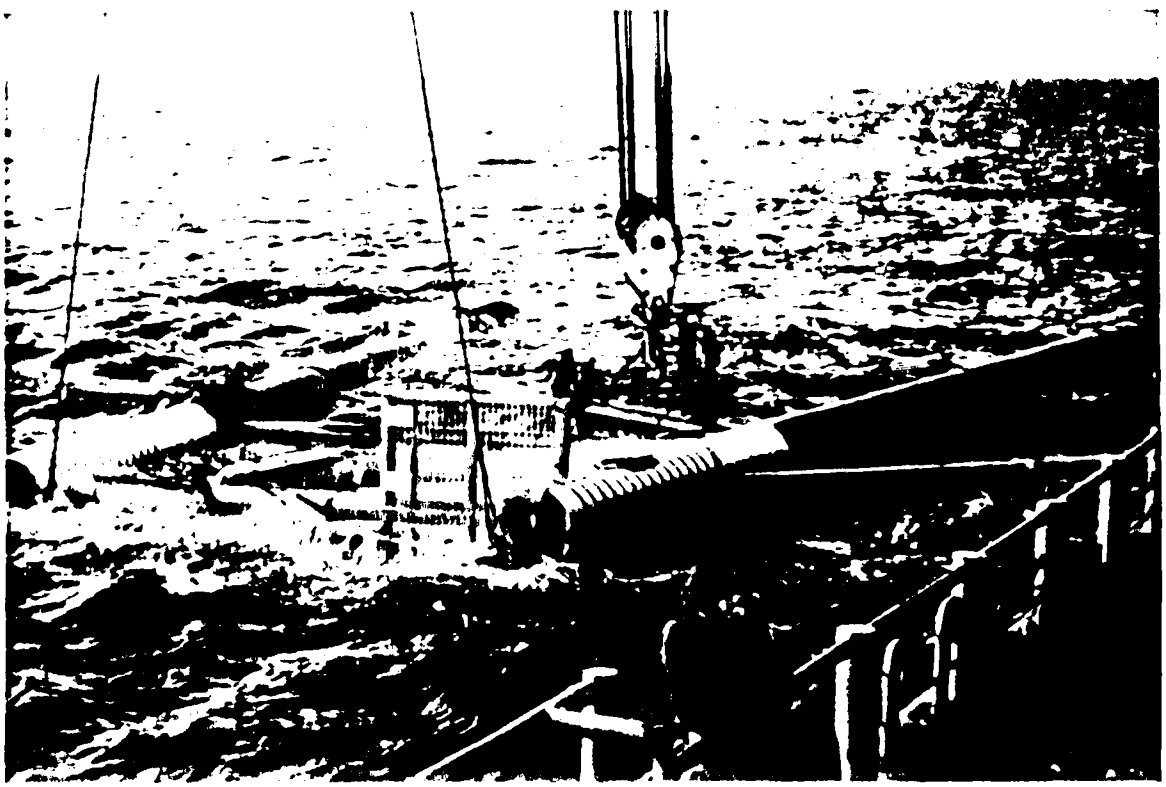
From the standpoint of sequence of operations, the towers were to be erected in the order #2, #3, #4, and #1. This sequence was formulated on (1) transportation considerations, i.e. one long and one short jacket could be shipped on each of two cargo barges, and a minimization of distance traveled between installation sites; and, (2) the *NAVAIRSYSCOM's* preference to have #2, #3, and #4 installed before tower #1. In the event weather prevented installation of four towers in 1977, the absence of tower #1 would have the least effect on overall range performance. Functionally, the erection procedure for each structure was as follows:

- The cargo barge would be brought alongside the pre-positioned derrick barge, weather permitting, Figure 12. Wire rope slings were attached to the two jacket lifting padeyes; sea fastening was removed; flood and vent valves were tested; water depth and location were rechecked.
- The crane lifted the jacket from the cargo barge and lowered it into the water, still in its lateral orientation. Because both ends of each jacket leg were sealed, the jacket would float horizontally with approximately one foot above the water's surface. (An auxilliary crane cable, attached to the top of two jacket legs, prevented the jacket from assuming a *nose-down* orientation due to the jacket's weight distribution.)
- Riggers transferred the main hook from the lifting slings to *righting* slings attached to the top of each jacket leg (Figure 13). A diver then opened flood valves at the base of each leg. As the legs began to flood the jacket began to right itself.



BARGE WITH TOWERS ALONGSIDE H. A. LINDSAY

FIGURE 12



DIVERS TRANSFERRING LOAD LINES ON JACKET

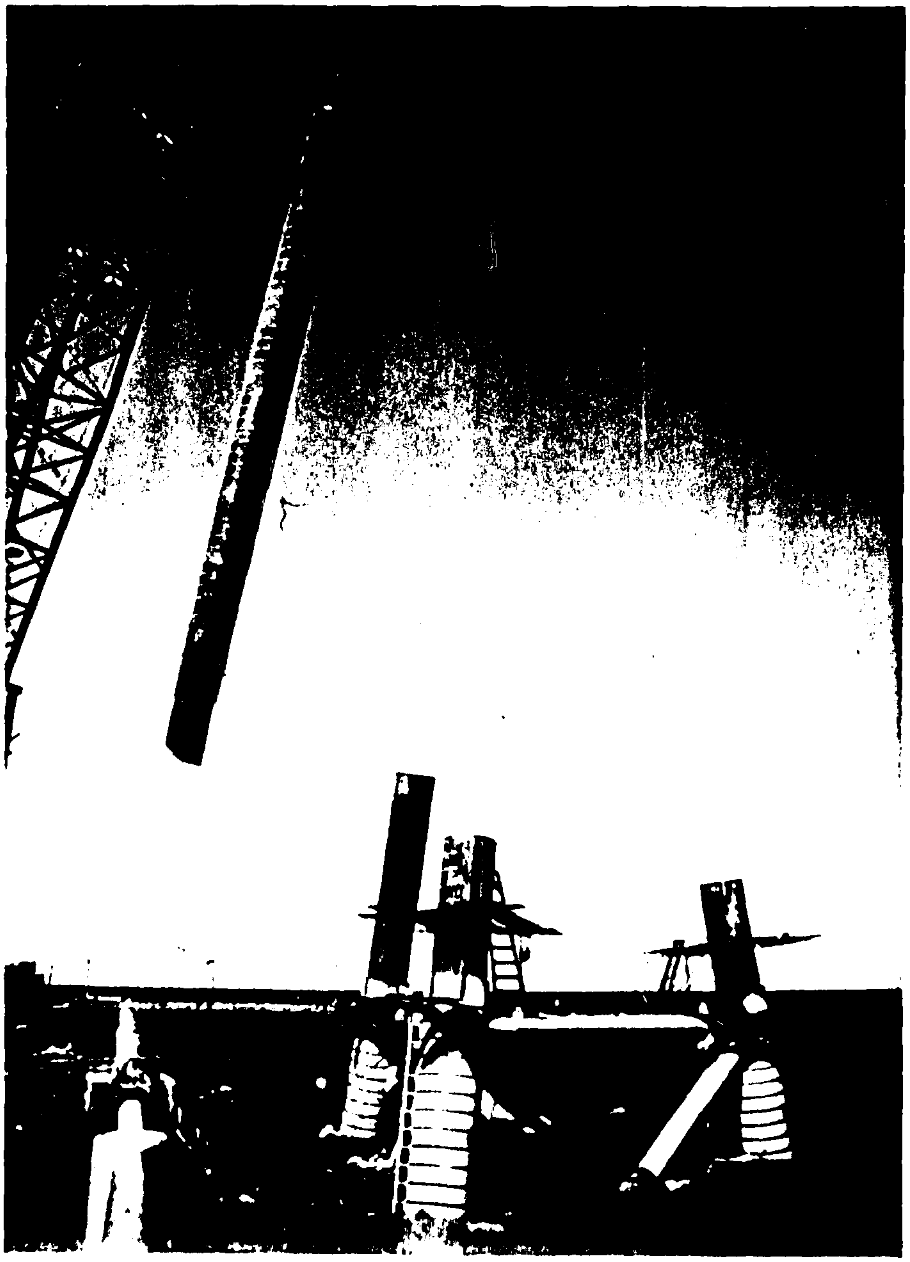
FIGURE 13

- The crane lifted, positioned, and set the jacket in its proper vertical orientation adjacent the marker buoy. The time required to set the jackets varied from 4 to 6 hours, excluding unnecessary delays, (see construction delays, below). Riggers and welders required two hours to attach lifting hardware and remove sea fastenings; another 2 to 4 hours were required to lift, lower, orient, and position the jacket on the sea bottom, Figure 14.

CRANE LOWERING A JACKET

FIGURE 14

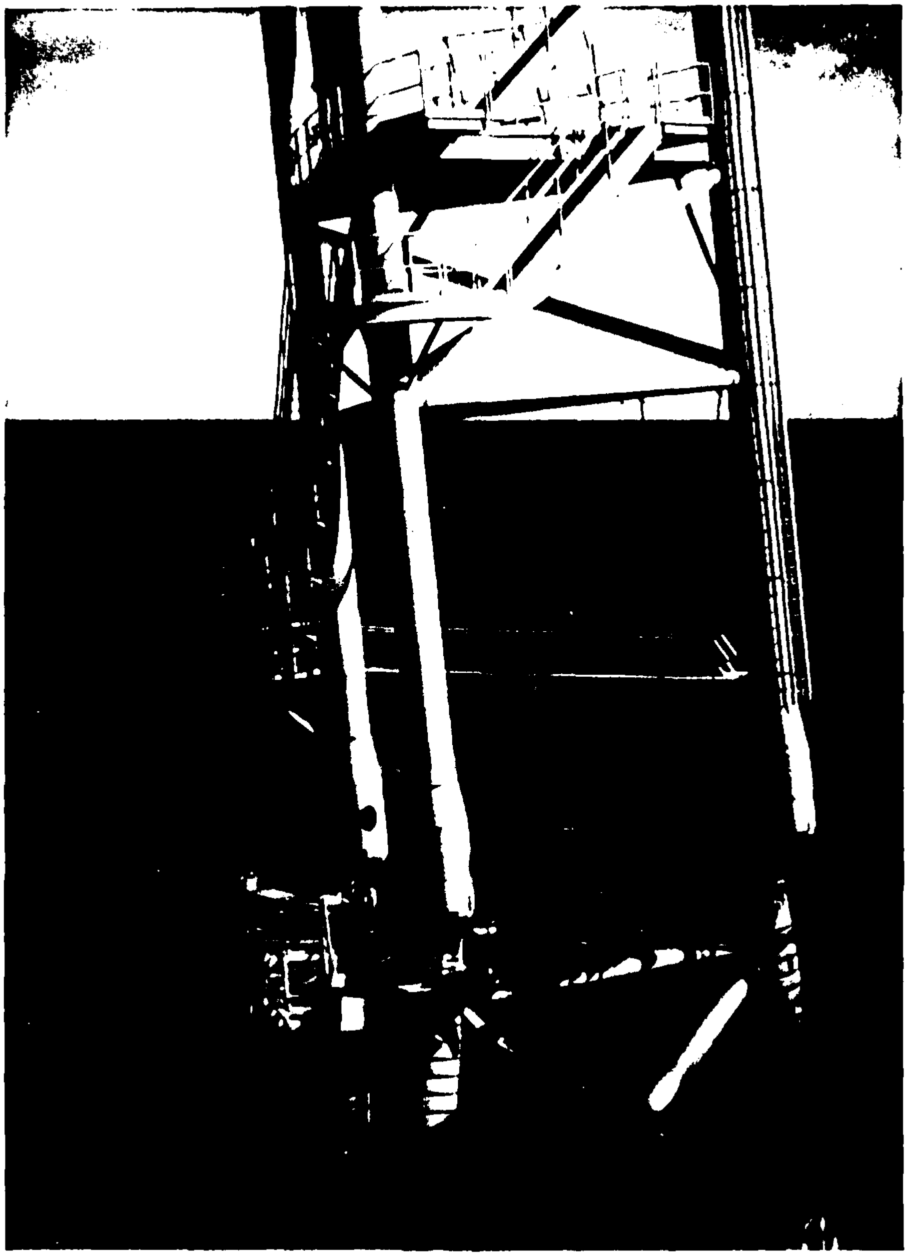
- o The cargo barge with piling was brought alongside the *LINDSAY*, after divers had retrieved the lifting slings and welders had removed the top closures from each leg.
- o The first (P-1) sections of piling were stabbed into each of the three jacket legs, Figure 15. An 040 steam-driven pile hammer was used to drive each lead pile through the rubber diaphram closure, and approximately seventy feet into the sea floor.



STABBING PILES INTO THE JACKETS

FIGURE 15

- One by one, the second sections of piling were stabbed and welded out. Five welders required nearly six hours to complete the two-inch deep circumferential pile splice. Each weld was ultrasonically inspected (see weld inspection). The second sections were driven with either the 040, 060 or 560 hammers, depending on soil resistance. The add-on process was repeated until all piling had been driven to grade.
- The jacket was leveled to within acceptable tolerance.
- Shims were placed in the annulus between pile and jacket leg, and welded out. The boat landing and barge fenders were installed. Excess lengths of piling were removed.
- The cargo barge with superstructure was brought alongside the *LINDSAY*. The crane lifted, positioned, and lowered the superstructure into place; i.e. stabbing cones at the base of each column were set into the tops of the three pilings, Figure 16. Although a seemingly difficult task, the crane operator was able to set each superstructure within ten minutes after lifting it from the cargo barge.
- While welders completed the superstructure column-to-pile splice, riggers and electricians installed the panels of solar cells, navigational aids, and battery boxes. Contractor divers inspected the jacket to ensure it had not been damaged during installation and recovered any construction debris.
- Following each of the government acceptance inspections, the construction crew would correct these deficiencies which could be immediately attended. They would then retrieve the *LINDSAY's* anchors and proceed to the next installation site. The remaining deficiencies were corrected by an independent six-man repair crew prior to the completion of the fourth *ACMR* tower on 21 August 1977.



SETTING THE SUPERSTRUCTURE

FIGURE 16

WEATHER DELAYS

Weather conditions precluded the contractor from continuing offshore construction operations a total of 196.5 hours. These conditions included heavy rains, high winds and seas, and/or dual swells (long-crested ocean waves arriving from two or more directions). A breakdown of weather hour delays by operation and condition is provided in Table 8.

TABLE 8 WEATHER HOUR DELAYS (IN HOURS)

OPERATION	CONDITION: HIGH WAVES	WAVES W/HIGH WINDS	DUAL SWELLS	STORM ACTIVITY
PLACING ANCHORS	-	-	-	-
SETTING JACKET	14.0	1.5	11.5	-
PILING, STABBING	38.0	14.5	-	6.0
PILE DRIVING	-	8.0	63.0	12.5
SETTING SUPERSTRUCTURE	-	-	-	-
WELDING	15.0	4.0	-	8.5
TOTAL	67.0	28.0	74.5	27.0
NOTE (1)	(2)	(3)	(4)	(5)

NOTES:
(1) SEE APPENDIX B
(2) AS DEFINED IN WEATHER HOUR GUIDELINES (W.H.G.)
(3) HEIGHT OF WAVES LESS THAN W.H.G., BUT COMBINED WITH HIGH WINDS
(4) COMBINED WAVE HEIGHT OF SWELLS LESS THAN W.H.G.
(5) HEAVY RAIN AND/OR LIGHTNING; WAVES LESS THAN W.H.G.

The longest weather delay occurred during installation of tower #4. The *LINDSAY* had arrived and set anchors by 0900, 20 July. Because of heavy seas and dual swell conditions, lift of the jacket could not begin until 2000 (8 p.m.) the following day. An additional 56 hours were lost when weather conditions deteriorated again, immediately after setting the jacket. The first lead pile was not stabbed until 1100 on 24 July.

EQUIPMENT MAINTENANCE

The most prevalent equipment problem was maintaining sufficient pile driving equipment. Each of the four pile-driving hammers was down for various periods of time; causes included: (1) replacement of worn cushion blocks; (2) replacement of ram keeper pins; (3) frequent repair or replacement of steam fittings and valve gaskets; and (4) replacement of the valve casing of the 060 hammer. The auxiliary boiler twice required replacement of numerous tubes; in hindsight, these probably could have been replaced before coming offshore. Fortunately, the surplus of hammers and the availability of the main boiler to support pile driving limited these equipment delays to less than 24 hours.

During stabbing of the 177 foot lead piles, the tops of the piles would frequently impinge on the crane boom and main block cables. During tower #3's installation, the piling became entangled in the 30-part

cable of the main block, and frayed two wire strands. Fourteen hundred feet of cable had to be cut off and discarded; thereafter, because of the reduced cable length, the main block was rigged with 26 parts, thus reducing the crane's capacity by 8 percent. Repair of the main block cable delayed operations seven hours over the course of the project. Repair of boom keeper shims delayed operations an additional 4 to 6 hours.

Potentially, the most serious equipment failure was the fracture of the shaft of the crane's port swing gear during installation of tower #4. Had the shaft of the starboard swing gear failed prior to repair of the port unit, it would have immobilized the crane and stopped operations, indefinitely. Fortunately, the contractor was able to obtain a replacement shaft in Norfolk the following day. Construction delay was limited to the six hours necessary to rework and replace the damaged shaft.

DELAYS IN LEVELING THE JACKET

The contractor was required by the specifications to level each jacket to within two inches between legs. Typically, driving of the first P-1 pile caused that corner of the jacket to lower. The remaining corners of each jacket then had a tendency to *climb* their piles during driving. The contractor tried a number of alternatives including: (1) ensuring the jacket was as level as possible when set; (2) extracting and restabbing the P-1 piles; (3) selective driving of add-on sections; and, (4) intermittently affixing the jacket legs and piles by welding. Despite these attempts, each jacket was 4 to 10 inches out of level at completion of pile driving (piles at grade). The contractor used one or more 100T hydraulic jacks and 100 to 200 ton crane force, to lift the low leg of each jacket to within 4 1/2 inches level of the other legs. This level status was accepted by the *ROICC* with the stipulation that pile extension lengths be appropriately adjusted to ensure the superstructure would be set level. Remedial measures of leveling required an average of approximately eight hours per jacket.

MISCELLANEOUS DELAYS

The survey crew initially placed the marker buoy for tower #2, three thousand meters off location due to a positioning equipment error. Eight hours were lost setting and recovering the *LINDSAY's* anchors.

The tug, *MISTER DON*, became entangled in the *LINDSAY's* anchor lines during installation of jacket #2. The jacket remained suspended in its vertical orientation from the crane for three hours, while divers removed the line from the tug's screws.

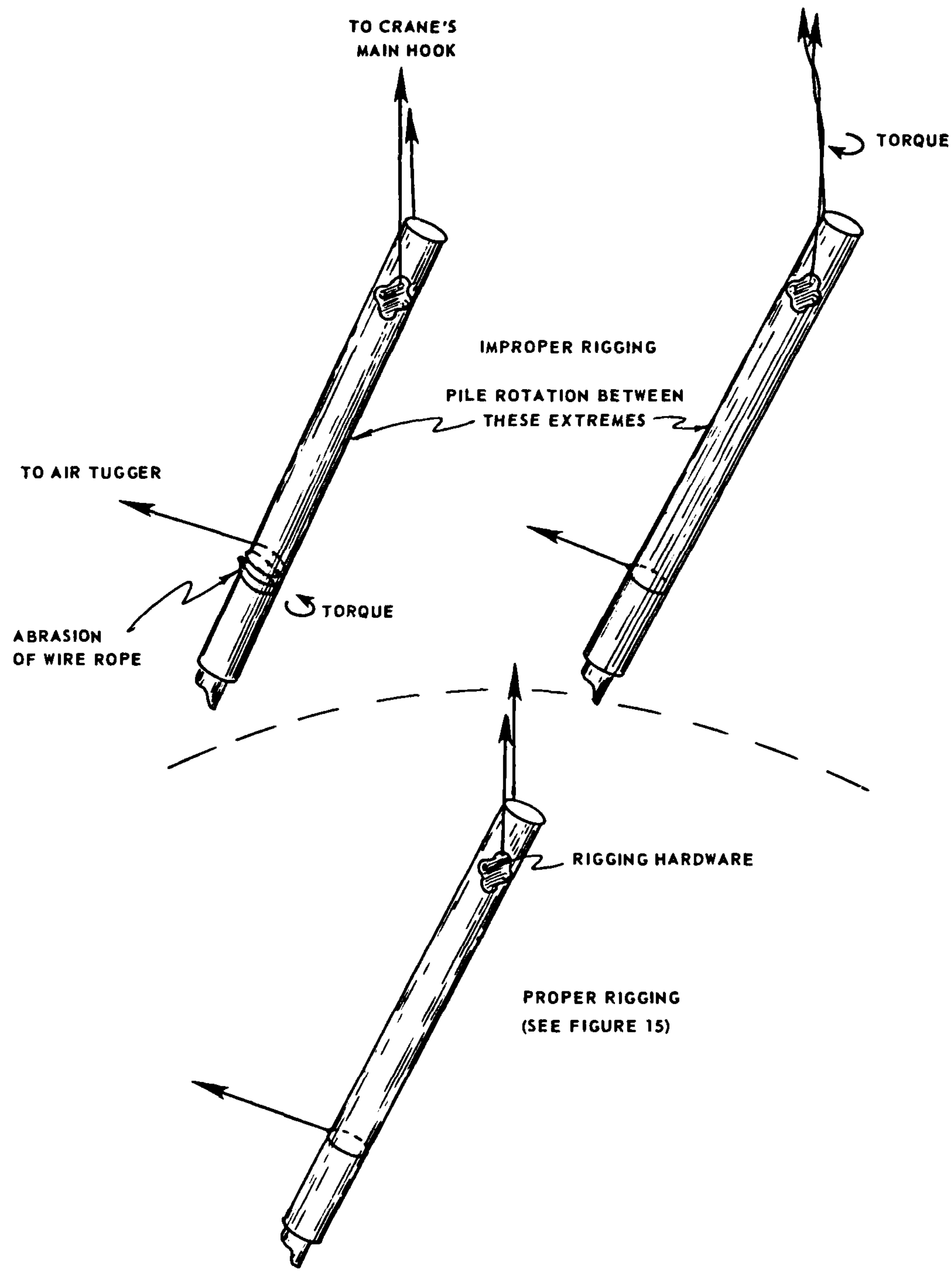
Jacket #2 was initially placed 20° from its intended N-S orientation. The misorientation was not discovered until the first lead pile had been stabbed. Three hours were required to withdraw the lead pile and reorient the jacket.

Tugger lines restraining the motion of the piling during stabbing operations snapped in two on six different occasions. The crane operator was forced to set the piling back down on the pile barge or immediately into the water to dampen its dangerous pendulum motion. Contractor personnel attributed the lines' failure to the snap loading as the pile responded irregularly to barge motion. Improper rigging may also have contributed significantly since on each occasion, riggers had inadvertently worked in a torque into the lifting hardware, Figure 17. Such a torque certainly caused abrasion of the wire as the pile rotated in response to the different lines. These six occurrences impeded job progress about six hours total.

In one instance, the combination of heavy seas, tug force, and human inattention forced the *LINDSAY* against jacket #4. Fortunately, damage to the jacket was minor -- a 10-foot x 3-foot section of coating was scrapped from one leg (leg c). Four hours were required to reposition the *LINDSAY's* anchors, and repair/replace welding leads damaged during the mishap. The damaged area was subsequently coated with *Splash Zone* paint by divers while other construction operations were underway.

WELD INSPECTION

Each of the field splices in the piling were 100% inspected by



RIGGING FOR STABBING PILES

FIGURE 17

ultrasonic testing in accordance with AWS D1.1-75, sections 6 and 8. During inspection of the pile splices of the first two towers, (#2 and #3), this inspection revealed occasional small weld discontinuities. These defects were readily repaired by arc gouging, rewelding, and reinspection.

CQC inspection of the initial two pile splices on tower #4, however, indicated a weld discontinuity near the root, completely around the piles (360°). Closer inspection indicated that the defect was possibly in the weld between the add-on section and its stabbing cone -- a weld made in the fabrication yard. This assumption was verified when inspection of the yard weld of add-ons lying on the deck of the derrick barge indicated the same discontinuity. Attempts to grind and/or carefully arc-gouge the weld to visually cite the defect were unsuccessful. The contractor took the position that the ultrasonic indication was a *ghost reflector*, and that the welds were in fact perfectly sound. After on-site consulting with NDT representatives of both *CHESNAVFACENGCOM* (Mr. G. Anadale)and *NAVFAC* (Mr. T Dawson), the *ROICC* established the government's position that the weld was rejectable by AWS standards, and unless destructive testing -- as required in procedure qualification -- verified weld integrity, the yard weld would have to be repaired. The contractor did not desire to pursue a testing program; thus, each of the yard welds in add-on lengths of piling for towers #4 and #1 were inspected on the deck of the derrick barge; at least 75% of these welds indicated the same type and location of reflector (presumed discontinuity) over 20 to 100% of the pile's circumference. The defective areas were then arc-gouged and repaired by rewelding. While over 100 man-hours were involved, the majority of these repairs were accomplished either during periods of bad weather or when other construction tasks were underway; thus, the penalty to actual construction time was limited to less than 12 hours.

The cause of the yard weld defect was never resolved in the minds of all personnel. The possibilities include: (1) a geometric or *ghost* discontinuity, such that sound was reflected back to the transducer through some unknow path as a result of the yard weld's curved surface; or, (2) a dendrite line or interface between the dissimilar base and

weld metals. A third possibility involves a combination of these two. Two *CQC* welding inspectors, the *CQC* representative, and a government *QA* welding inspector had each verified the discontinuity on deck in the yard welds of add-on piling. However, during the piling installation of the fourth tower (#1), a second *QA* welding inspector reinspected yard welds that had been identified for repair. Although he located the suspected reflector, it was well within acceptable ultrasonic tolerance. Subsequent inspection by *CQC* also indicated acceptance. Thus, it seems likely that a minute reflector -- the geometric surface in the case of the yard weld and possibly a dendrite line between the yard and field welds in the completed splice -- was misevaluated by the earlier weld inspection. If in fact human error was the cause, repair was certainly in favor of ensuring a sound weld.

OFFSHORE ACCOMMODATIONS

The *H. A. LINDSAY*, is a 300' x 90' x 19' ABS and Coast Guard approved offshore construction barge. In addition to its fully-revolving, 350T-capacity crane, the *LINDSAY* was equipped with pile driving hammers, welding machines, lifting tackle and sufficient small tools, parts, and supplies, for extended construction operations at sea. Air conditioned quarters and mess facilities were available for 85 men. The *ROICC* staff was allotted two four-man bunk rooms, and a small office with tables, chairs, and file cabinets. Food was of excellent quality and quantity; hot meals were served four times each day. Both laundry and custodial service were available as required.

LOGISTICS

The contractor had established a shore-facility base station in a seemingly dilapidated, but adequate, building adjacent to the U. S. Coast Guard Station at Little Creek, Va. Two contractor personnel manned the facility between 6 a.m. and 6 p.m. each day throughout the installation period. They were responsible for procurement of supplies and spare parts and for monitoring incoming telephone communications. Two-hundred and fifty feet of pier space was available adjacent to the base station for berthing the contractor's two offshore supply vessels -- the *DAMIEN* and the *CRISTOBAL*. The *DAMIEN* was used extensively as the primary

personnel-transfer and food-resupply boat, and was used for offshore survey operations. The slower *CRISTOBAL* was used primarily for transferring non-perishable supplies and construction materials. Personnel transit to the installation sites was available on an unscheduled, approximate, bi-daily basis except during periods of rough weather. Transit time between shore and the installation sites varied from 3 to 8 hours depending on the site distance, the available supply vessel, and prevailing sea conditions.

COMMUNICATIONS

Both SSB (frequencies 4139.5 and 6210.4kHz) and VHF radio were available for ship-to-shore transmissions and communication between the contractor's vessels. *ROICC* personnel were able to contact *CHESNAVFACENGCOM* on VHF circuit by radioing the Norfolk Marine Operator who would in turn patch the signal into local telephone circuits; however, VHF was an unsecured net, i.e. any vessel operating in the area, including the contractor's tugs, could receive the transmissions. Thus, frequently, *ROICC* personnel were required to abruptly end radio conversations with *CHESNAVFACENGCOM* rather than discuss and possibly compromise contractual matters. In one instance, the *ROICC* chose to transit to shore to discuss weather hour guidelines with Command representatives rather than discuss their contractual significance over radio.

SAFETY

By contract, the contractor was required to comply with all pertinent provisions of the Corps of Engineers Manual, EM 385 1-1, except that all diving was to be in accordance with best safe commercial practice (Contract Modification P00002).

Construction at sea is inherently dangerous, and *ACMR* construction was no exception. Riggers were required to work atop high, unstable structures without guardrails or lifelines; to rig a 10-ton main hook while balancing themselves on two- and four-foot diameter pipes which floated just above the dynamic surface of the ocean; and to transfer heavy equipment and material to and from supply boats in high seas ($H_{1/3}$ = 6 feet). Welders were required to stand on sixteen-inch wide, slanted and, occasionally, wet planking without guardrails or safety

lines for periods as long as four hours while welding pile splices. Divers swam beneath the 200T jacket to open flood valves at the base of each leg as the jacket floated on the water's surface; and divers inspected the jackets and retrieved debris from 100-foot depths in currents estimated at over three knots.

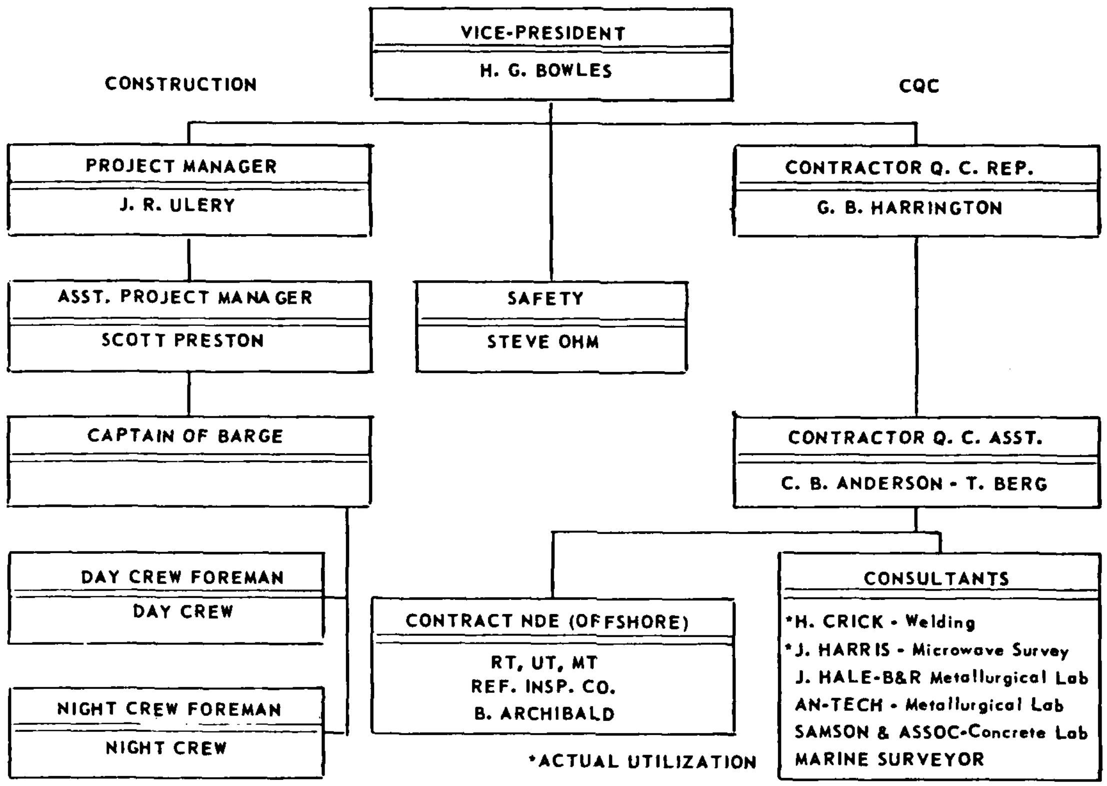
The majority of personnel were acutely aware of the dangers associated with offshore construction and took appropriate precautions. A few, however, frequently required a reminder to don hard hats and life vests. During installation of tower #3, it became necessary to demand an additional safety emphasis from all hands. Although this demand caused the most serious deterioration in relationship between construction crew and the *ROICC* staff, safety consciousness notably improved.

There were but four lost-time accidents. The most serious was the result of one man swinging an eight-pound sledge hammer; the hammer glanced off its target, and struck the man's assistant in the back of the neck. Fortunately, the extent of the injury was no more than a severly sprained neck.

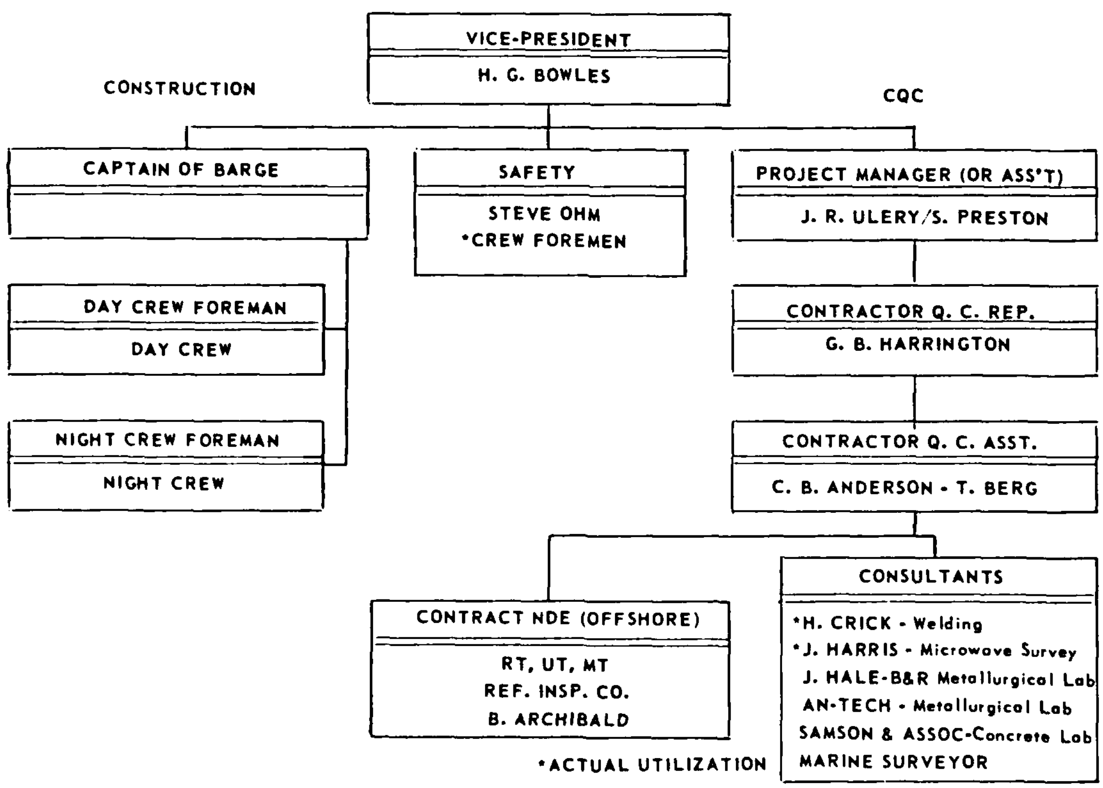
QUALITY CONTROL

The contractor's quality control organization, as proposed, is shown in Figure 18A. Functionally, however, quality control was effected through an organization structure similar to that of Figure 18B. In effect, the project manager performed the duties of *CQC* representative. The designated *CQC* representative functioned as his assistant. This latter arrangement was effective for the following reasons:

- By the contractor's normal mode of operation, quality was the responsibility of the crew and welding foremen who were assisted, as required, by NDT inspectors. Thus, crew foremen were not accustomed to interfacing with a *CQC* representative;
- The barge captain has ultimate responsibility for the safety of the barge and personnel, and has overall charge of construction operations;
- The project manager was by profession an engineer; and was the individual most familiar with the installation plan.



(PROPOSED) CQC ORGANIZATION OFFSHORE FIGURE 18A



CQC ORGANIZATION OFFSHORE - EFFECTIVE FIGURE 18B

- Thus, there was a sharing of mutual respect between the project manager and barge captain.

Where an unfamiliar *CQC* representative with limited offshore experience would have encountered difficulty dealing with the barge captain during periods of stress, the project manager was able to effectively implement quality control requirements while maintaining a harmonious working relationship among all parties. If the contractor's quality control program was to be faulted, it would be in the area of responsiveness. On many occasions, the designated *CQC* representative or his assistant had to be reminded by the *ROICC* staff of upcoming inspection tasks.

In one instance, just prior to painting the shim plates of tower #2, the *ROICC* staff measured and found the majority of jacket-to-shim plate welds undersized. The welds had already been ground smooth for painting. Dr. John McCann, structural designer for the A & E and onboard as a *QA* inspector for the *ROICC* staff, calculated that a 1 1/4-inch weld (vice 1 5/8-inch called for in the contract drawings) was sufficient to develop the necessary design load transfer across the joint. Thus, these welds were finished to a minimum 1 1/4-inch fillet size and reground. The *CQC* representative was advised that similar welds of the remaining towers were to be 1 5/8-inch. While quality control was the responsibility of the contractor, the *ROICC* staff had responsibility for quality assurance. The *ROICC* staff consisted of the *ROICC*, one or more *AREICC/AROICCs*, a structural engineer, and an NDT inspector. As occasion warranted, the *ROICC* staff was additionally augmented by NDT representatives from *NAVFACENGCOM* and *CHESNAVFACENGCOM*; and a pile driving consultant during tower #4's installation. This team performed continuous construction surveillance -- around the clock, seven-days-per-week throughout the ten week installation period.

Both the structural engineer and NDT inspector were hired by contract with the design A & E firm. Thus, they were able to perform valuable functions such as evaluating and approving, on behalf of the A & E, changes to the design drawings; assisting in resolution to construction problems; and monitoring the *CQC* weld inspections. However, they did not share -- nor could they be expected to have -- the same degree of personal responsibility and motivation, necessary to stay abreast of

construction operations and anticipate potential problems, as the government inspectors (*ROICC*, *AROICC*, *AREICC*). Thus, it was imperative that at least one government inspector be available at all times.

POST-INSTALLATION SITE SURVEY

After completion of the final tower, the contractor performed a precision survey to determine accurately the location of each tower; contractually, the survey results were to be of first order.

Bodie Island Lighthouse and Wright Memorial Monument had sufficient elevation, hence line of sight could be used on shore bench marks. Distances and angles between each of the towers and shore monuments were measured with a K & E Rangemaster II Laser and K & E theodolite. Corrections for spherical distances, U. T. M. grid distances, and spherical excess were calculated. Location results for three different coordinate systems are provided in Table 9. Accuracy is reported to be within 0.9 meter tolerance. A more detailed description of the survey results and procedures is available in reference [16].

TABLE 9 EAST COAST AIR COMBAT MANEUVERING RANGE PLATFORM LOCATIONS

	GEOGRAPHIC	U.T.M.	N.C. STATE
ACMR 1	N 35 56 59.5646	N 3 978 221.727	X 3 104 922.448
	W 75 15 58.1461	E 475 996.616	Y 821 413.558
ACMR 2	N 36 13 35.4728	N 4 008 901.268	X 3 105 805.429
	W 75 15 01.1123	E 477 504.380	Y 922 223.264
ACMR 3	N 36 03 53.2239	N 3 990 933.505	X 3 186 934.355
	W 74 58 59.3154	E 501 518.059	Y 866 475.872
ACMR 4	N 35 47 11.2302	N 3 960 067.671	X 3 157 867.525
	W 75 05 42.1955	E 491 409.740	Y 763 921.184

GEOGRAPHIC COORDINATES REFERENCED TO CLARKE'S SPHEROID OF 1866.

U.T.M. COORDINATES ARE UNIVERSAL TRANSVERSE MERCATOR GRID COORDINATES REFERENCED TO CLARKE'S SPHEROID OF 1866 IN METERS, ZONE 18, CENTRAL MERIDIAN 75 DEGREES WEST.

N. C. STATE IS STATE PLANE COORDINATE GRID SYSTEM IN FLEET, ZONE 3200.

DATUM IS NATIONAL GEODETIC VERTICAL DATUM (NGVD) 1929.

INSTALLATION SUMMARY

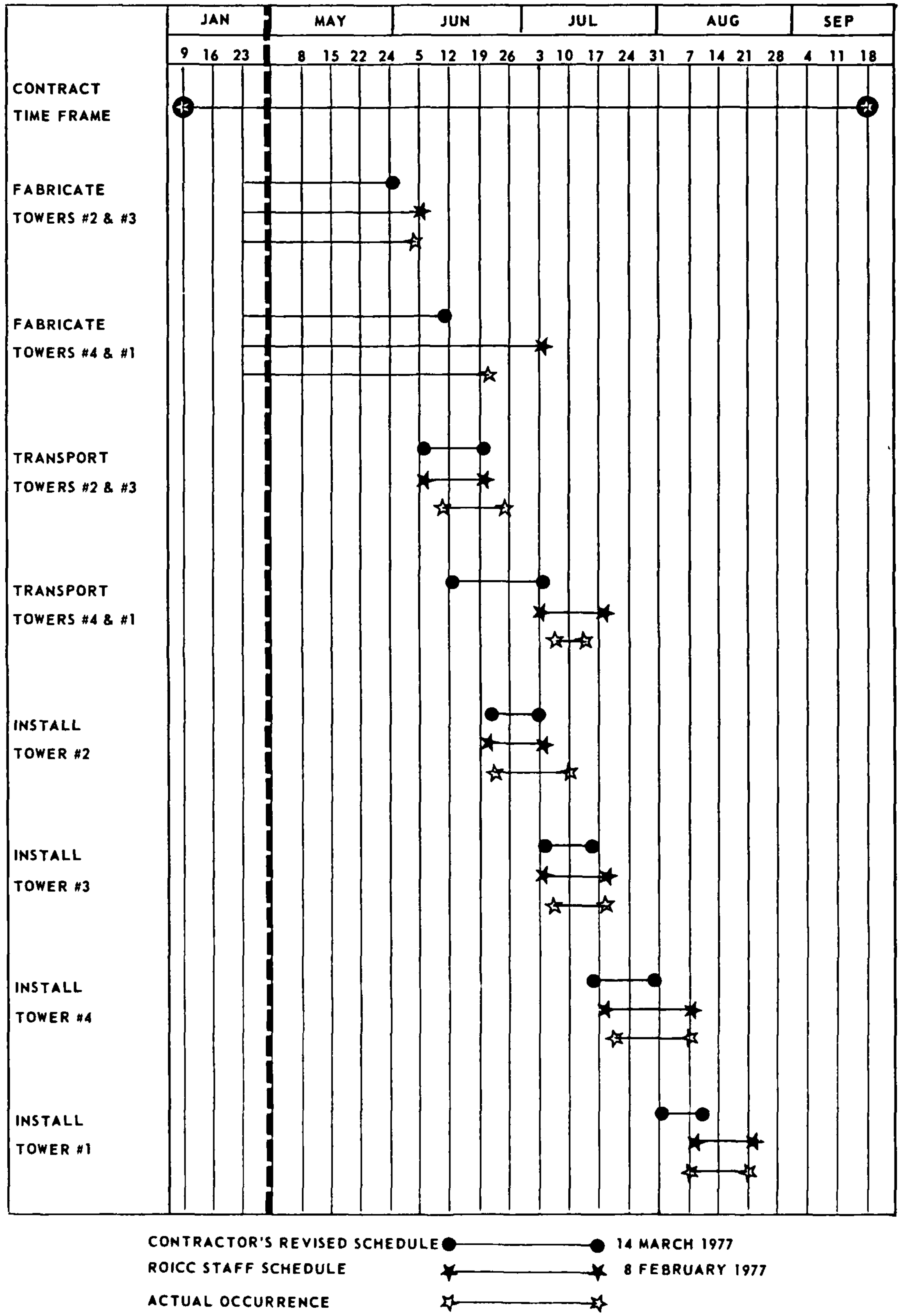
Each of the four towers was installed in a manner similar to that described in the sequence of operations. Construction delays due to weather and equipment maintenance had been anticipated and considered during project planning. Unanticipated problems did occur, but the accumulated delays were more than recovered by the time savings in pile driving.

Recall that several steps had been taken during the design phase to assure driveability. These steps included using a constant and considerable (2-inch) piling thickness; a driving shoe; selective lengths of add-ons; and ensuring the availability of a 300,000 ft-lb hammer. Each is believed to have contributed significantly to the pile driving success, thus eliminating the requirement for remedial work. Only at site #4 and then only after all four hammers were down for a period of four hours -- allowing the piling sufficient time to set up -- did pile driving approach 60% of the refusal criteria (500 BPF with 560 hammer). Actual blow counts for the other three towers were unexpectedly low. Considering the four precautionary steps, subsequent review of the driving records concluded "that each of the 12 piles is well founded and can be expected to provide adequately the utltimate axial pile resistance for which it was intended", reference [17]. The twelve driving log records are available in Appendix E.

In summary, each tower was completed safely; with adequate quality control; and, remarkably, almost exactly on schedule, Figure 19. Copies of the offshore situation reports (*ROICC SITREPS*) are provided in Appendix F.

CONSTRUCTION SCHEDULES

FIGURE 19



SECTION VII

GOVERNMENT ACCEPTANCE INSPECTION

BACKGROUND

The construction contract provided for inspection and acceptance of each tower by the Government as promptly as practical after completion by the contractor. Each of the four government acceptance inspections consisted of two phases:

(1) that portion of each tower above mean-low-water was inspected by the *ROICC* or his appointed assistants; and,

(2) that portion of each tower below the water's surface was inspected by *SEABEE* divers of Underwater Construction Team ONE (*UCT ONE*).

ROICC INSPECTION

At the request of the contractor, the *ROICC* staff performed the topside (Phase 1) inspections while the contractor was completing final welding and painting on each tower. Cited deficiencies included areas of defective or deficient paint coating; damaged swing motor housings of two jib cranes; a defective fog horn switch on tower #3; and one or more damaged solar cells on towers #1 and #2.

Rather than await repairs, the contractor would move the derrick barge to the next installation site immediately upon completion of the government's topside inspection. Subsequently, during the period 12 to 20 August, a 5 to 8 man repair crew, accompanied by the *ROICC ACMR*, returned to each tower site aboard the supply vessel, *CRISTOBAL* to correct the deficiencies. Thus, each of the deficiencies was corrected without delaying construction progress, and prior to completion of the last tower (#1) on 21 August 1977.

GOVERNMENT UNDERWATER INSPECTION

Subsequent to completion of each tower, *UCT ONE* divers performed an extensive visual inspection of each critical jacket weld and each

anode to insure that the quality of workmanship was sound and that the jackets were not damaged during installation. The divers also obtained baseline data of each tower's electro-potential and sea bottom conditions. This baseline data will be useful in future years to evaluate the effectiveness of the cathodic protection system and the extent of bottom scour.

The only noted construction deficiency was that a towing signal aid on tower #4 had, inadvertently, not been removed before setting the jacket. Contractor divers returned to site #4 during construction of tower #1, and removed the signal aid with a hacksaw.

The success of the underwater inspections can be partially judged by the responsiveness with which they were accomplished. The fourth and last of the underwater inspections was completed less than six hours after the contractor's barge had moved away from the completed tower. The timeliness of this inspection was well within the most optimistic estimates.

The ocean construction platform *SEACON*, which was used to support the government diving operations, is considered an over-kill as an inspection vessel. However, for this assignment, the *UCT ONE-SEACON* combination provided the *ROICC* with a responsive inspection capability. Because of the contract requirement of a soon-as-practical inspection, the possibility of demurrage charges of $60,000 per day for contractor delays, and the uncertainty of the tower completion schedule, an equivalent, responsive, commercial inspection capability could not have been achieved except through contract for a summer-long standby diving force at an excessive (estimated $200K) cost.

A detailed report of the underwater inspection procedures and findings is available as reference [18].

SECTION VIII

SUMMARY

In less than two years the four *ACMR* towers were designed, fabricated, and installed -- the result of the combined efforts of engineers and construction personnel of Crest Offshore; TERA, Inc.; Brown & Root Marine Operators, Inc.; Underwater Construction Team ONE; and *CHESNAVFACENGCOM*.

Under an accelerated schedule, *CHESNAVFACENGCOM* and Crest Offshore were able to develop a design-to-cost structural configuration and to prepare acceptable contract provisions and specifications -- acceptable to both construction contractor's and government policy.

A key to project success on the construction side was the cooperation among all participants. Crest, TERA, and *CHESNAVFACENGCOM* were responsive to all contractor questions and problems. Certain non-essential detailing requirements were waived in favor of the contractor, who in turn corrected numerous design detailing errors, all at no additional contract cost. When maintaining material toughness through fabrication became an issue, the contractor cooperated by choosing an alternate, more costly fabrication technique -- without seeking additional compensation. Offshore, under tense construction and environmental conditions, contractor and government representatives worked harmoniously -- the *ROICC* staff frequently sharing in construction decisions involving pile driving, job sequence, and job progress during marginal weather situations.

LESSONS LEARNED

CHESNAVFACENGCOM is under no illusion that government ocean construction contracting is state-of-the art. On the contrary, there remain many contracting policies which will have to be dealt with on an individual contract basis -- particularly that of fixed price -- low bid awards. As one ocean contractor has indicated, in order to be low bidder, a company must either spend much money (presumably on developing

precise estimates of contingency situations), or make a mistake. As long as the oil industry continues to offer sufficient and lucrative cost-plus-fee contracts, A & E's and contractors will be reluctant to pursue government contracts actively.

The full-time, on-site availability of the *ROICC* staff both onshore, during fabrication, and offshore during transportation and installation was considered significant in avoiding both contractor delays and monetary claims. A government representative was always available to provide responsive answers and solutions to contractor questions and problems.

Significant savings in weather hour payments were realized as a result of the *ROICC* staff offshore actions. Many times, during marginal or predicted unfavorable weather conditions, the contractor would express a desire to wait and see whether conditions would deteriorate or improve. *ROICC* personnel were required and often effective in *pushing* the work -- by identifying other tasks which could be accomplished under existing conditions or encouraging the contractor to pursue current efforts. To the contractor's credit -- frequently, at other times, the construction crews performed through periods of marginal weather with no government prodding. Without this diligence and cooperation on behalf of the crews, the towers could not have been completed by the close of the weather window in late August 1977.

It is significant that the majority of weather delays were caused by conditions other than those considered either in the weather hour guidelines of the contract specifications (Appendix B) or in the government's analysis of weather hours. For example, conditions such as dual swells and storm activity were not discussed. Also, because of the heavy lifts involved, pile driving, and pile stabbing could not be safely accomplished in seas greater than five feet. Fortunately, actual sea conditions during the summer of 1977 were better than predicted. This, combined with contractor perseverance and *ROICC* staff prodding, resulted in total weather delays 30% less than predicted. Procedures for estimating and guidelines for payment of future-project weather delays need to be revised.

Loss of the material properties -- fracture toughness -- during fabrication was not anticipated. The best knowledge available to *CHESNAVFACENGCOM* indicated that post-fabrication testing is uncommon in the offshore industry. Contracts normally specify the material properties of the plate necessary to satisfy the design requirements; but the detrimental effects of fabrication often go undetected. Fortunately, on this project, the problem was surfaced by independent *ROICC* testing and an alternate, acceptable fabrication technique was utilized.

Similarly, problems with jacket leveling were not expected. In hindsight, members of the contractor's crew reflected that in their experience, maintaining the level of battered structures is normally difficult during pile drivings; however, in softer soils, remedial measures to level the jacket after pile driving are usually successful. Attempts to level the *ACMR* structures were met with difficulty because of the pile and soil's resistance to deform. A 300-400-ton force was required to raise each jacket within 4 1/2 inches of level.

The underwater inspection by divers of *UCT ONE* revealed two unexpected conditions. First, the jacket legs had not achieved the penetrations into the sea bottoms that were desired (3 ft) and expected. This was attributed to the dense upper sand layer. The net effect was to reduce the allowance for scour around the jacket legs. Secondly, the negative voltage potential measurements were considerably less than that expected of corrosion-protected steel. It was recognized that the inspections were performed without sufficient time for steel polarization, which can normally take from three to six months with sacrificial anodes in seawater. Both scour about the jacket legs and the effectiveness of the sacrificial anodic protection system should be subjects of future investigation.

The most successful phase of installation was that of pile driving. Both the experience of the offshore oil industry in similar soils, and the analytic studies of driveability using the wave equation indicated that obtaining pile design penetration would be very difficult, if not impossible, without resorting to remedial work or insert piles. The pile design and the 300,000 ft-lb hammer were felt to have contributed significantly to driveability. Although design phase predictions

would indicate that the actual blow counts experienced were unexpectedly low, hindcast wave equation analysis and on-site observation of pile set-up with time give indications of the adequacy of the piles as installed. Future pile designers should recognize the limitations in the wave equation analysis and not rely solely on personal experience.

FINANCIAL DATA

Costs associated with designing, constructing, and managing the execution of this *MCON* project are summarized in Table 10. Costs include only those since *MCON* authorization.

SUMMARY

The experience gained by *CHESNAVFACENGCOM* and the offshore industry, as a whole, was valuable. Project accomplishment provided for an interchange and understanding of the policies and procedures of each. Most significant was the cooperation exhibited by both sides -- in essence, as *partners* in a successful endeavor. Hopefully, this experience will provide a framework from which to contract for future Navy ocean construction.

The *ACMR* project was a success story. Design and construction were accomplished well within the original *MCON* budget, and remarkably almost exactly on schedule. These offshore towers, Figure 20, serve as a visible example of *NAVFAC's* ocean engineering and ocean construction contracting capability to support Fleet Readiness.

ADDENDUM

A *slide* presentation summarizing the *EC/ACMR* ocean tower construction is included as Appendix G. The slides may be obtained on loan from *CHESNAVFACENGCOM* upon request.

TABLE 10

EC/ACMR TOWER PROJECT COST DATA (1)

COST CATEGORY	FUND SOURCE (2)			
	PROJECT	SIOH	OTHER	TOTAL
DESIGN:				
A & E CONTRACT	413,558			$ 413,558
DQA CONTRACT	72,364			$ 72,364
GOVT. IN-HOUSE				163,900
LABOR	159,900			
COMPUTER	4,000			
CONSTRUCTION:				
CONST. CONTRACT	11,101,385		10,000	11,111,385
ROICC SUPPORT (3)				269,285
GOVT. LABOR	45,000	34,000		
MISC. (40		23,000		
A & E QA	53,482	104,653		
DQA	7,150			
NDT	2,000			
UNDERWATER INSPECTION: (5)				102,700
LABOR		47,000		
TRAVEL & PER DIEM		2,600		
SEACON USAGE		29,000		
MISC. SUPPORT	10,900	13,200		

(1) MCON PHASE ONLY

(2) APPROXIMATE DOLLAR FIGURE

(3) DOES NOT INCLUDE 1.5 MAN YEARS MILITARY SALARIES

(4) TRAVEL, EQUIPMENT RENTALS, PRINTING

(5) DOES NOT INCLUDE UCT ONE PERSONNEL SALARIES

TOWER INSTALLATION COMPLETED

FIGURE 20

REFERENCES

1. "Performance Specification for Ocean Structures for the East Coast Air Combat Maneuvering Range", FPO-74001, June 1974, Change #1, February 1975.

2. Naval Facilities Engineering Command, Headquarters, Speedletter 021/WSE, 9 December 1975.

3. "Structural Concept Analysis Report for the East Coast Air Combat Maneuvering Range, Offshore Kitty Hawk, North Carolina", Contract N62477-76-C-0179, Report No. 27-771-92 to Chesapeake Division, Naval Facilities Engineering Command, Contract No. N62477-76-C-0179, Washington, D. C. by Crest Engineering, Inc., Tulsa, Oklahoma, May 1976.

4. "Environmental Design Criteria Report for the East Coast Air Combat Maneuvering Range, Offshore Kitty Hawk, North Carolina", Contract N62477-76-C-0179, Report No. 27-771-91 to Chesapeake Division, Naval Facilities Engineering Command, Contract No. N62477-76-C-0179, Washington, D. C. by Crest Engineering, Inc., Tulsa, Oklahoma, May 1976.

5. "East Coast Air Combat Maneuvering Range (EC/ACMR), Ocean Structures, Review of Systems Analysis Phase", Report No. 76-10-1 to Chesapeake Division, Naval Facilities Engineering Command. Contract No. N62477-75-C-0112, Washington, D. C., by TERA, Inc., Austin, Texas, June 1977.

6. "East Coast Air Combat Maneuvering Range Offshore Kitty Hawk, North Carolina", Contract Reports Nos. 27-771-94 to 27-771-100 to Chesapeake Division, Naval Facilities Engineering Command, Contract No. N62477-76-C-0179, Washington, D. C., by Crest Engineering, Inc., Tulsa, Oklahoma, September 1976.

7. "East Coast Air Combat Maneuvering Range Offshore Kitty Hawk, North Carolina", NAVFAC Specification No. 21-76-0180, September 30, 1976, including Amendments No. 1 through 5.

8. "East Coast Air Combat Maneuvering Range (EC/ACMR), Ocean Structures-Review of Design Phase", Report No. 76-16 to Chesapeake Division, Naval Facilities Engineering Command, Contract No. N62477-75-C-0112, Washington, D. C., by TERA, Inc., Houston, Texas, September 1977.

9. "API Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms", (API-RP2A), 7th ed., American Petroleum Institute, Dallas, Texas, January 1976.

REFERENCES (Cont'd.)

10. Department of the Army, Corps of Engineers, Shore Protection Manual, Vols. I, II, and III, 1975.

11. "Structural Welding Code, AWSI D1.1, Rec. 1-76", American Welding Society, Inc., Miami, Florida, 1976.

12. "East Coast Air Combat Maneuvering Range (EC/ACMR), Ocean Structures Specialized Engineering Services During Pile Driving", Report No. T77-11 to Chesapeake Division, Naval Facilities Engineering Command, Washington, D. C., by TERA, Inc., Houston, Texas, October 1977.

13. "Foundation Investigation, East Coast ACMR Ocean Structures", Report No. 275-001 to Cubic Corporation by McClelland Engineers, Inc., New Orleans, LA, September 1975, Vol. I and II.

14. "Stress Wave Equation Analyses, East Coast ACMR Ocean Structures", Report No. 275-001 to Cubic Corporation by McClelland Engineers, Inc., New Orleans, LA, October 1975.

15. "Installation, Transportation and Sea Fastening Plans for Four Tripod ACMR Structures Offshore Kitty Hawk, North Carolina", Brown & Root Marine Operators, Inc., (Spring 1977).

16. "Survey of the East Coast Air Combat Maneuvering Range", Brown & Root, Inc., Electronic Survey Operations, 18 October 1977.

17. "EC/ACMR Ocean Structures - Specialized Engineering Services During Pile Driving", TERA, Inc., October 1977.

18. "ACMR Inspection Completion Report", FPO-1-78(2), October 1977, CHESNAVFACENGCOM.

APPENDIX A

CONTINGENCY PLANNING
ACMR WHAT-IFS?

CONSTRUCTION

CONTRACTOR HAS NOT COMPLETED FABRICATION (DUE TO WEATHER OR OTHERWISE) BY THE 171st DAY?

- o Apply pressure only. Request contractor employ additional men, hours, and/or days; or other fabrication yard
- o Maintain progress payment retention
- o Request progress chart update with responsive schedule

ONE OR MORE TOWERS IS LOST/SEVERELY DAMAGED DURING TRANSPORTATION/ INSTALLATION?

- o If recoverable...salvage, inspect for structural damage, repair if structurally feasible
- o If not recoverable/usable...*NAVAIRSYSCOM* would prefer towers #2, #3, and #4 above any other combination. Tower #1 could be modified for installation at sites #2, #3, or #4. Modification would cost an estimated $300K and would have to be accomplished *now* (May 1977) if substitution of tower #1 was to be made in CY77. Question becomes: Is it worth $300K to ensure that a tower is at sites #2, #3, and #4 instead of another 3-site combination?
- o Preventive Action: Brown & Root has a sea fastening plan which has been reviewed and approved by a certified marine surveyor; also has contingency plans for bad weather during transportation and installation.

WEATHER CAUSES DOWNTIME DURING INSTALLATION

- o Goal is to install, as a minimum, three towers.
- o Break even point of continuing on site vs cost of *DEMOB/MOB*?
  - *DEMOB/MOB* cost to install in CY78 as follows: $1.5M, $2.3M, $3.0M, $3.5M to install 1, 2, 3, and 4 towers, respectively.
  - Weather day cost is $60K/day. Therefore, for example, *DEMOB/MOB* cost for tower #1 only, is equivalent to 25 weather days.

- A & E and Brown & Root need 10 to 12 days of good weather to install tower #1 (assuming no remedial work required).
- Therefore, break even point can be defined as that date when bad weather is predicted 67% (25/37) of the next 37 days. Based on A & E data, bad weather percentage never exceeds 50%. Operations should never be discontinued...so long as available project funds hold out.

o In reality, should bad weather cause excessive delays during the summer months, A & E's weather data would be considered questionable, at best. Based on summer weather information, and reassessment of the degree of expected weather deterioration through the summer, construction would be broken off when anticipated bad/good weather ratio exceeds two.

o Additional funding dollars should be sought if tower #1 installation has not commenced by September 1.

o Preventive Action: Government will *push* offshore work.

THERE IS A NATURAL DISCHARGE OF OIL, METHANE GAS, OR FRESH WATER?

o If fresh water, would not be detectable until too late to prevent excessive discharge; disregard.

o If initial pile has been driven greater than 50 feet, *continue driving*. Upon completion, give contractor NTP to plug hole with concrete and/or drill mud; contractor has high pressure grout pump on scene. If less than 50 feet, attempt to withdraw pile and then plug hole. Consider other site alternatives.

o During pile driving, analyze driving log to ascertain foundation support, and remedial actions, if required.

o Report spill to:
  - Commander, Coast Guard, 5th District (804) 393-9´11
  - U. S. Environmental Protection Agency, Region IV (404) 526-5727

- State of N. C., Dept. of Natural & Economic Resources (919) 829-4984
- *CHESNVAFACENGCOM*, Environmental Engineering Branch (202) 433-3761

42" PILE DOESN'T ADVANCE AFTER DRILLING 30" PILOT HOLE?

- o Review driving log to assess whether pile penetration sufficient. Possible Alternatives:
  - Drill a larger hole: *ROICC* has approved use of a 32" drill bit after consulting with *EIC* and A & E. A larger bit size would be unacceptable.
  - Use insert pile procedures: Probability of premature refusal after use of 32" drill less than 1%. If this risk unacceptable, insert piles should be fabricated *now*, at estimated cost of $100K per tower. Risk is sufficiently low (1%), that fabrication of inserts for towers #2, #3, and #1 not economical.
  - Use under-reamer and concrete (cast-in-place) bell: If risk of premature refusal (1%) is unacceptable, design of reinforced bell should be initiated now and Brown & Root should be tasked to have under reamer available. Total cost of bell design and contract modifications estimated at $60K. Risk sufficiently low, that this precaution not economically justified.
- o The cost of installing piles or a cast-in-place bell are relatively equivalent (assuming one or the other is required), $500K ($\pm$) per tower. Each is equally favorable to the *EIC*. Therefore, should it become necessary to choose between the two, the decision would be made based on which is more responsive. The insert pile procedure is preferred because:
  - Should inserts be required on tower #2 or #3, inserts for tower #4 could be used. Contractor would be given immediate change order to fabricate additional inserts as soon as possible.

- If tower #4 inserts are insufficient in length, temporary NAVAIDS would be placed on jacket under construction; Notice to Mariners would identify same. Tower would be completed when additional inserts available.

TOWER LISTS EXCESSIVELY AFTER ACCEPTANCE DUE TO WIND, WAVES, OR BOTTOM CONDITIONS?

- o Contractual problems; must determine whether act of God, design, or construction deficiency.
- o Run stress analysis to ascertain structural problems.
- o Monitor future settlement.

DESIGN

BPF AT GRADE IS LESS THAN MINIMUM ACCEPTABLE?

- o What is minimum acceptable? 85-125 BPF (for 42" pile).
- o If 85 BPF not achieved:
  - Review data for possible error
  - Drive 1 to 2 additional feet and carefully note BPF
  - Allow pile to set-up 24 hours, drive 1 to 2 feet again
  - Weld on an additional length of pile from another tower's assets; additional pile for second tower would be required but probability of such requirement is sufficiently low that purchase of additional pile to cover this contingency not economically justifiable.
  - Task A & E to reevaluate design and options during 24 hour set-up after 1 to 2 foot redrive.

WATER DEPTH AT DESIGN COORDINATES DOES NOT EQUAL DESIGN MLW ± 1 FT?

- o Contractor required to conduct bathymetric survey ± 1/2 mi.
- o Tower design tolerant to increasing water depth criteria to -1/+4 ft MLW
- o Positioning of towers outside ± 1/2 mile of site will require complete repositioning assessment of each tower by both *NAVAIRSYSCOM* and A & E. Not justified at this time.

CONTRACTOR CANNOT MEET HORIZONTAL TOLERANCE CRITERIA (+ 2 IN. BETWEEN COLUMNS)?

- o Contractor shall level bottom by jetting and/or drilling
- o Contractor will shim prior to placing superstructure

RESOURCES

LOSS OF MAJOR INSTALLATION EQUIPMENT AT INSTALLATION SITE?

- o Contractor tasked to have back-up equipment on site
- o If derrick/barge fails, matter for surety company

STEEL NOT AVAILABLE ON SCHEDULE?

- o *ROICC* and A & E have considered material substitutions
- o *DCAS* forms submitted
- o No longer an issue as of 5/1/77

FUEL CRISIS AFFECTS THE AMOUNT OF POL AVAILABLE FOR JOB?

- o Request *DCAS* assistance
- o Navy fuel available out of Norfolk

GFE NAVAIDS DO NOT ARRIVE ON TIME?

- o Government provide emergency equipment
- o Process change order to have NAVAIDS installed when available

  NOTE: As of 6/8/77, all GFE received except solar panels for towers #4 and #1 and batteries for NAVAIDS. Batteries and solar panels are enroute to Norfolk by contractor's request.

GFE NAVAIDS DO NOT FUNCTION DURING TEST OUT OR AFTER INSTALLATION?

- o Task contractor to replace
- o Preventive Measure: Government has extra NAVAID's available. Contractor will test each NAVAID in fabrication yard.
- o Only four solar panels (furnished by (*NAVAIRSYSCOM*) are available. However:
  - GFE batteries are sufficient for 30 days of NAVAID operation without recharge from solar panel.

- Each solar panel has multiple, independent units; complete panel failure unlikely - if so, CUBIC would have to be tasked to effect repairs within 30 days.

THE INSTALLATION IS INCOMPLETE AND ALL ALLOTTED FUNDS ARE EXPENDED?

o If all but tower #4...approach customer for decision

o If less than 3 towers...ask Congress for deficiency funding

UNCONTROLLABLES

TOWERS ARE IN PATHS OF AIR/SEA TRAFFIC?

o Preventive Measures:
  - During review of installation plan, reinforce contractor responsibility for signal lights
  - Ensure federal agency issues Notice to Mariners
  - Ensure range manager (*NAS* Oceana) is apprised of construction tasks

FOREIGN TRAWLERS INTERFERE WITH CONTRACTOR'S OFFSHORE OPS?

o If trawler on exact site, wait until it repositions or vary installation site with ± 1/2 mile (acceptable limits).

o If foreign trawler interferes, alert State Department. Law of the Sea governs.

o If U. S. flag vessel interferes, notify Coast Guard to mediate and/or arrest, if necessary.

STRIKES?

o Steel Plant: *NAVFAC* P-306 provides guidelines; i.e.
  - submit DD Form 1507 to CHESDIV 021A and MAT-02L
  - remain impartial

o Fabrication Yard or Offshore Crew
  - Brown & Root is non-union contractor. Allow contractor to new-hire. Remain impartial.

PERSONAL INJURIES TO GOVERNMENT PERSONNEL?

o Coast Guard maintains SAR units at Oregon Inlet (sea rescue) and Elizabeth City, N. C. (heli-rescue) on ready alert status. Coast Guard monitors Channel 16; rescue unit could be on site within 1 and 1 1/2 hours.

- Contractor will maintain FA station on derrick barge. Contractor also has informal contract with local helicopter for emergency rescue needs.
- *ROICC* has prepared Diving Emergency Checklist for UCT inspection operations.

ENVIRONMENTALISTS ATTEMPT TO STOP PROJECT?

- Action
  - Do not attempt any physical action against person or persons at the site or remove any obstructions placed at the site.
  - Notify Commanding Officer, Chesapeake Division, Naval Facilities Engineering Command and CHESDIV, Legal Counsel, immediately, and explain in detail the specific situation.
  - CHESDIV, C. O., Code 00, and CHESDIV, Legal Counsel, Code 09C, will assess the situation and will:

    a) Provide guidance on further action,

    b) Notify NAVFAC Headquarters, other Navy organizations, U. S. Coast Guard and other authorities as deemed necessary.

APPENDIX B

WEATHER CLAUSE PROVISIONS

SECTION 02420

WEATHER DAY CONSIDERATIONS

1. GENERAL: This section sets forth the conditions under which the Contractor will be entitled to payment by the Government, at the rate bid for Bid Item 1(d), for hours during which the combination of wind, waves, and swell are such that, if operations continue, personnel, the work, equipment, and/or vessels in the immediate vicinity of the work would be endangered. The determination of whether or not such conditions exist shall be the sole responsibility of the Contractor to be made in accordance with the principles set forth in this Section. Disagreements between the Contractor and the Contracting Officer as to whether environmental conditions are such that work cannot be performed shall be resolved in accordance with the Disputes Clause. However, the Contracting Officer will not direct the performance of this work over the objection of the Contractor in such instances; this shall not affect the right of the Government to seek payment of liquidated damages or of the Contractor to seek payment for weather hours, as may be authorized by other provisions of this contract, in accordance with the Disputes procedure.

2. WEATHER HOUR DEFINITION: A weather hour shall be one of the 24 equal periods of a calendar day, Saturdays, Sundays, and holidays included, in which the Contractor cannot perform for the reasons set forth in preceding paragraph.

*3. APPLICABILITY: The following statements define when and under what circumstances weather hours shall be allowed and payment therefore made at the rate bid under Bid Item 1(d):

(a) Weather hours shall be allowed only when both the derrick barge/ship and the structures to be installed are at the installation site. Weather hours shall not be allowed

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*Bid Opening No. 1, As Is

For Bid Opening No. 2, See Amendment No.0004 (Copy Attached)

during transportation, except when the combination of wind, waves, and swell is such that vessels or equipment necessary for continuing performance of work cannot safely leave port.

(b) Weather hours shall not be allowed for any period during which work does not take place or could not take place because of any reason which is the fault of the Contractor or any of his subcontractors or suppliers at any tier, even though the weather conditions during that particular hour would otherwise warrant the hour considered as a weather hour.

(c) If the Contractor should work during conditions which would otherwise have entitled him to a weather hour, such time shall not be a weather hour.

(d) Weather hours shall be allowed only during the period between 15 May 1977 and 15 August 1977, provided, however, that the 15 August 1977 date shall be extended on a day-by-day basis for each 24 weather hours in excess of 312 which occur after 15 May 1977. The Contractor shall assume all weather risks prior to or subsequent to such period.

(e) The clause of this contract entitled "Variation in Estimated Quantities" shall not apply to any variations in the number of weather hours.

*4. WEATHER DELAYS INCLUDED IN SCHEDULE: The completion schedule set forth elsewhere in this contract is predicated upon the assumption that the Contractor will, during the period 15 May 1977 through 15 August 1977, be precluded by weather conditions from working on 312 clock hours. The 15 August 1977 completion date will be extended, if more than 312 weather hours are encountered, in accordance with the clause of this contract entitled "Termination for Default-Damages for Delay-Time Extension."

5. BID EVALUATION: For bid evaluation purposes only, bids will be evaluated on the assumption that 312 weather hours, for which compensation will be paid, will be encountered.

6. WEATHER HOUR GUIDELINES: Outlined hereinafter are certain environmental conditions which, in themselves, will be deemed as authorizing payment for weather hours during which the indicated type of work was to be performed, if in fact work is not performed. The term "wave height" as used hereinafter refers to the significant wave height which is the average height of the upper one-third of the waves in a wave train.

6.1 Position Survey: Placing the buoy marking the installation site: Wave height exceeding 8 feet.

6.2 Installation:

6.2.1 Placing derrick barge/ship anchors: Wave height exceeding 8 feet.

6.2.2 Template: Operations to set the template may not be initiated unless environmental conditions and predictions are favorable to complete the operation without shutdown beginning with the lifting of the template from the cargo barge through flotation, upending and setting. Actual or predicted heights in excess of 4 feet if a derrick barge/ship is used, or in excess of 6 feet if a self-elevating barge is used, are considered adverse to the completion of this sequence.

6.2.3 Piling:

(a) Offloading and stabbing piling: Wave heights exceeding 6 feet.

(b) Continuation of pile driving already commenced: Wave heights exceeding 8 feet.

(c) Jetting of piling: Wave heights exceeding 6 feet.

(d) Piling soil plug removal: Wave heights exceeding 6 feet.

6.2.4 Superstructure lifting and setting: Wave heights exceeding 5 feet.

6.2.5 Personnel working at the template walkaway level: Wave heights exceeding 6 feet.

6.2.6 Derrick Barge/Ship: The derrick barge/ship may be moved back from the template when wave heights exceed 12 feet.

6.2.7 Self-Elevating Barge: The self-elevating barge may not attempt to lower into the seas and pull back from the template when wave heights exceed 6 feet.

END

AMENDMENT NO.0004

SECTION 02420

WEATHER DAY CONSIDERATIONS

3. APPLICABILITY: Delete the existing paragraph 3 in its entirety and substitute the following:

"3. APPLICABILITY: Weather hour delays associated with transportation shall be subject to Clause Five - Time Extensions and Disputes clauses of the General Provisions. The following statements define when and under what circumstances weather hours shall be allowed during installation and payment therefore made at the rate bid under Bid Item 1(d):

(a) Weather hours shall be allowed only when both the derrick barge/ship and the structures to be installed are at the installation site.

(b) Weather hours shall not be allowed for any period during which work does not take place or could not take place because of any reason which is the fault of the Contractor or any of his subcontractors or suppliers at any tier, even though the weather conditions during that particular hour would otherwise warrant the hour being considered a weather hour.

(c) If the Contractor should conduct operations during conditions which would otherwise have entitled him to a weather hour, such time shall not be a weather hour. However, Contractor's effort to perform "miscellaneous" work such as repairs or equipment maintenance will not preclude the time being considered a weather hour.

(d) Weather hours shall be allowed only during the period between 15 May 1977 and the contract completion date defined elsewhere in this contract.

(e) The clause of this contract entitled "Variation in Estimated Quantities" shall not apply to any variation

in the number of weather hours. The rates specified in Bid Item 1(d) shall be appropriate regardless of actual number of weather hours incurred."

4. WEATHER DELAYS INCLUDED IN SCHEDULE: Delete the existing paragraph and substitute the following:

"The completion schedule set forth elsewhere in this contract is predicated upon the assumption that the Contractor will, during the period 15 May 1977 through the contract completion date, be precluded by weather conditions from working on 312 clock hours. The contract completion date will be extended, if more than 312 weather hours are encountered, in accordance with Clause Five - Time Extensions."

APPENDIX C

TYPICAL SHIPPING MANIFEST SHEETS

AD-A163 320 EAST COAST AIR COMBAT MANEUVERING RANGE (EC/ACMR) OCEAN TOWER CONSTRUCTIO..(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE.. MAR 78 2/2

UNCLASSIFIED CHES/NAVFAC/FPO-1-78(4) F/G 13/13 NL

END

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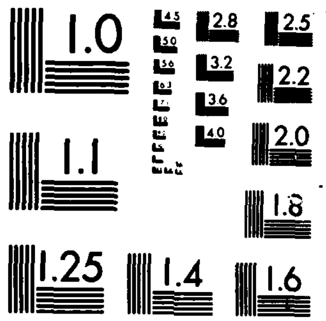

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 21, 19 77

AUTHORITY ______ APPROVAL ______

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION	
1.	ea	1	Jacket #1 for 81' Water; True Length 101'3"	145 Tons
2.	ea	1	Jacket #4 for 105' Water; True Length 125'3"	185 Tons
3.	ea	1	Deck Superstructure #1	150 Tons
4.	ea	1	Deck Superstructure #4	150 Tons
			MAIN PILE PLATFORM #1	
5.	ea	3	42" OD Piling 148'1" lg. Tag: P-1-1 42 x 1-3/4 W Pipe 12' lg. 42 x 1-1/2 W Pipe 134' lg. 42 x 2.00 W Pipe 2'1" lg.	147 Tons
6.	ea	3	42" OD Piling 57' lg. Tag: P-2-1 42 x 2.000 W Pipe 22' lg. 42 x 1-3/4 W Pipe 35' lg.	67.5 Tons
7.	ea	3	42" OD Piling 67' lg. Tag: P-3-1 42 x 2.00 W Pipe 67' lg.	85.5 Tons
8.	ea	3	42" OD Piling 61'6" lg. Tag: P-4-1 42 x 2.00 W Pipe 61'6" lg.	79.5 Tons
			MAIN PILE PLATFORM #4	
9.	ea	3	42" OD Piling 57'3" lg. Tag: P-2-4 42 x 2.00 W Pipe 57'3" lg.	73.5 Tons
10.	ea	3	42" OD Piling 57'3" lg. Tag: P-3-4 42 x 2.00 W Pipe 57'3" lg.	73.5 Tons
11.	ea	3	42" OD Piling 62'3" lg. Tag: P-4-4 42 x 2.00 W Pipe 62'3" lg.	79.5 Tons
12.	ea	3	42" OD Piling 56'6" lg. Tag: P-5-4 42 x 2.00 W Pipe 56'6" lg.	72 Tons
			INSERT PILES PLATFORM #4	
13.	ea	3	33" OD Piling 30'3" lg. Tag: P-5-1 33 x 1.000 W Pipe 30'3" lg.	15 Tons
			JACKET TO PILE SHIMS	
14.	ea	14	1" Plate 18-5/8" x 3'-1/2"	
15.	ea	47	1-1/8" Plate 18-5/8" x 3'-1/2"	

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT ______

DATE SHIPPED ______ 19__

RECEIVED BY ______

SHIPPING MANIFEST

BROWN & ROOT, INC. WESTERN
SHIPPER HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 21, 19 77

AUTHORITY ______________ APPROVAL ______________

SHIP TO UNITED STATES NAVY B&R JOB 83-5357
OFFSHORE
ADDRESS KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION PAGE 2
16.	ea	14	1-1/4" x 18-5/8 x 3'-1/2" Plate
17.	ea	12	1-3/8 x 18-5/8 x 3'-1/2" Plate
			SUPERSTRUCTURE HANDRAILS PLATFORM #1 & #4
18.	lot	1	Handrails as follows: 6 ea. Type A 4 ea. Type RA 12 ea. Type B 2 ea. Type C 2 ea. Type D 2 ea. Type E 2 ea. Type F 4 ea. Type G 4 ea. Type H
19.	lot	1	Rigging on Jacket #1 as follows: 1 ea. 3" x 78'10" lg. Sling 1 ea. 3" x 73'6" lg. Sling 3 ea. 3-1/2" Safety Shackles
20.	lot	1	Rigging on Jacket #4 as follows: 1 ea. 3" x 73'6" lg. Sling

SHIPPING AND ROUTING INSTRUCTIONS ______________

SHIPPING WEIGHT ______________ METHOD OF SHIPMENT BARGE HM 262

DATE SHIPPED ______________ 19__

RECEIVED BY ______________

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 8, 19 77

AUTHORITY ____ APPROVAL ____

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION	
1.	ea	1	3-Pile Jacket #2 for 93' Water True Length 113'3"	170 Tons
2.	ea	1	3-Pile Jacket #3 for 105' Water True Length 125'3"	185 Tons
			MAIN PILE PLATFORM #2	
3.	ea	3	42" Piling 178'1" lg. Tag: P-1-2 42 x 2" Wall Pipe 176' lg. 42 x 2-1/2" Wall Pipe 2'1" lg.	225 Tons
4.	ea	3	42" Piling 57'3" lg. Tag: P-2-2 42 x 2" Wall Pipe 57'3" lg.	73.5 Tons
5.	ea	3	42" Piling 57'3" lg. Tag: P-3-2 42 x 2" Wall Pipe 57'3" lg.	73.5 Tons
6.	ea	3	42" Piling 57'3" Tag: P-4-2 42 x 2" Wall Pipe 57'3" lg.	73.5 Tons
7.	ea	3	42" Piling 55' lg. Tag: P-5-2	70.5 Tons
			MAIN PILE PLATFORM #3	
8.	ea	3	42" Piling 37' lg. Tag: P-2-3 42 x 2" Wall Pipe 37' lg.	48 Tons
9.	ea	3	42" Piling 52' lg. Tag: P-3-3 42 x 2" Wall Pipe 52' lg.	66 Tons
10.	ea	3	42" Piling 57' lg. Tag: P-4-3 42 x 2" W Pipe 57' lg.	73.5 Tons
11.	ea	3	42" Piling 56' lg. Tag: P-5-3 42 x 2 Wall Pipe 56' lg.	72 Tons
12.	ea	8	18" OD Boat Fenders w/tires	26.81 Tons
13.	ea	8	30" Cast Steel Boat Cleats w/Base Plate	
14.	ea	4	Stairway w/fixed Handrails Tag: 1-39-57	
15.	ea	2	1 x 3/16 Serr Bar Grating Galv 3'x20'	
			BOAT LANDING HANDRAILS PLATFORMS 2 & 3	
16.	ea	8	Type A	
17.	ea	4	Type B	
18.	ea	4	Type C	

SHIPPING AND ROUTING INSTRUCTIONS ____

SHIPPING WEIGHT ____ METHOD OF SHIPMENT ____

DATE SHIPPED ____ 19 ____

RECEIVED BY ____

SHIPPING MANIFEST

BROWN & ROOT, INC. WESTERN
SHIPPER HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GOLCHS BAYOU JUNE 8, 1977

AUTHORITY ______ APPROVAL ______

SHIP TO UNITED STATES NAVY B&R JOB 03-5357
OFFSHORE
ADDRESS KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	PAGE 2 DESCRIPTION
			JACKET HANDRAILS
19.	ea	4	Type D
20.	ea	4	Type E
21.	ea	4	Type F
22.	ea	4	Type G
23.	ea	2	5/16" x 60 x 240 Checkered Floor Plate
			RIGGING ON JACKETS
			PLATFORM #2
24.	ea	1	3-1/2" x 73'6" Slings
25.	ea	1	3-1/2" x 82'11" lg. Slings
26.	ea	4	3" Safety Shackles
27.	ea	2	5" Turnbuckles
			PLATFORM #3
28.	ea	1	3-1/2" x 73'6" Slings
29.	ea	1	3-1/2" x 82'11" Slings
30.	ea	2	3" Safety Shackles
31.	ea	16	39-1/4" OD x 625 W x 7' lg. Stabbing Point
32.	lot	1	Material for Temporary Work Deck as follows: 12 ea. 21" x 62# WF Beam 2'4-1/2" lg. 4 ea. 18" x 50# WF Beam 7'10" lg
33.	ea	3	24" x 18" Used Tires (Extra for Boat Landings)
34.	ea	1	42" OD x 5' lg. Buoy w/300 LF. 3/4" Cable

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT BARGE 374

DATE SHIPPED ______ 19__

RECEIVED BY ______

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 8, 1977

AUTHORITY ______ APPROVAL ______

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION
1.	ea	1	3-Pile Deck #2 75 Tons
2.	ea	1	3-Pile Deck #3 75 Tons
3.	ea	4	Boat Landings 54 Tons
			INSERT PILES - PLATFORM 4
4.	ea	3	33" Piling x 212'1" lg. Tag: IP-1 33 x 1.000 W Pipe 210' 33 x 1-1/2 W Pipe 2'1"
5.	ea	3	33" Piling x 122'6" lg. Tag: IP-2 33 x 1.000 W Pipe 122'6" lg.
6.	ea	3	33" Piling 32' lg. Tag: IP-3 33 x 1.000 W Pipe 32' lg.
7.	ea	3	33" Piling 32' lg. Tag: IP-4 33 x 1.000 W Pipe 32' lg.
			HANDRAILS FOR DECKS 2 & 3
8.	lot	1	Handrails as follows: 6 ea. Type A 4 ea. Type RA 12 ea. Type B 2 ea. Type C 2 ea. Type D 2 ea. Type E 2 ea. Type F 4 ea. Type G 4 ea. Type H
			JACKET TO PILE SHIMS
9.	ea	14	1" Plate 18-5/8 x 3'-1/2" lg. Shims
10.	ea	50	1-1/8" Plate 18-5/8 x 3'-1/2" lg. Shims
11.	ea	14	1-1/4" Plate 18-5/8 x 3'-1/2" lg. Shims
12.	ea	16	1-3/8" Plate 18-5/8" x 3'-1/2" lg. Shims
			THE FOLLOWING MATERIAL WAS ORDERED ON BROWN & ROOT WORK ORDER 83-5200-871 and 83-5777.
13.	LF	80	6-5/8" x 280 Wall Pipe 2 @ 40' REQUISITION NO. 085161
14.	LF	40	8-5/8" x 322 Wall Pipe 1 @ 40' REQUISITION NO. 085161

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT ______

DATE SHIPPED ______ 19__

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SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 8, 19 77

AUTHORITY ______ APPROVAL ______

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION PAGE 2
15.	LF	13	12-3/4" x 375 W Pipe 1 @ 13' REQUISITION NO. 085161
16.	LF	85'10"	6-5/8" x 432 W Pipe 1 @ 43'3", 1 @ 42'7" REQUISITION 08515
17.	LF	84	1-1/2" S/80 W Blk Pipe 4 @ 21' REQUISITION NO. 085156
18.	LF	22'10"	6-5/8" x 280 W Pipe 1 @ 22'10" REQUISITION NO. 085156
19.	LF	90	4" Full Hole Drill Pipe 3 @ 30' REQUISITION NO. 085158
20.	LF	800	2-3/8" Tubing 27 jts. REQUISITION NO. 085143
21.	LF	84	1" S/80 PE Blk Pipe 4 @ 21' REQUISITION NO. 085162
22.	ea	1	Schramm Mod 425/350 Hi-Pressure Air Compressor S/N 586729 REQUISITION NO. 097667
			HALLIBURTON MATERIAL
23.	ea	1	Twin Skid mounted H-T-400 Mud Pump #535 w/fuel tank loose
24.	ea	1	5" Blow hose
25.	ea	1	2" Tub Swedge
26.	ea	1	Low Pressure Mixer
27.	ea	1	High Pressure Mixer
28.	ea	1	Hopper
29.	ea	1	High Pressure Mixing Manifold
30.	ea	1	4" Mixing Manifold
31.	ea	2	1-1/2" Rubber Mixing Lines
32.	ea	1	Mixing Tub
33.	ea	1	5" Tub Suction
34.	ea	2	5" Suction Hoses 10' lg.
35.	ea	4	2" Chicksaw Swivel Joints
36.	ea	2	2" x 10' Steel Hose
37.	ea	1	3/4" x 25' Wash up Hose
38.	ea	1	2" x 50' Rag Hose

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT ______

DATE SHIPPED ______ 19__

RECEIVED BY ______

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR POINT OF ORIGIN GREENS BAYOU JUNE 8, 19 77

AUTHORITY ________ APPROVAL ________

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	PAGE 3 DESCRIPTION
39.	ea	1	Lead Off
40.	ea	1	2" x 2" Weco Valve
41.	ea	1	2" Weco Union Fig 1502
42.	ea	3	1-1/2" Weco Union Fig 200
43.	ea	2	2" x 4" XH Nipples
44.	ea	2	5" Blinds
45.	ea	3	Skid mounted 1230 Cu. Ft. Horizontal Pressurized Tanks #9823, #9821, #7078
46.	ea	1	Skid mounted 300 CFM Air Compressor #232 w/1 ea. 2# High Pressure Hose 25' lg.
47.	ea	1	Stand up 70 Cu. Ft. Surge Plate Tank #10
48.	ea	1	Skid mounted 4" Mud Pump #593
49.	bags	240	Calcium Chloride Peladow (#80 Bags)
50.	ea	4	2" Dayco Blue Ribbon All-Purpose Hose 50'
51.	ea	4	5" x 50' Hose
			ACCORD TOOL RENTAL MATERIAL
52.	ea	1	Skid Mounted Mud Tank 8' x 6' x 30' (200 Barrel) w/ 3 ea. Mud Guns, and 1 ea. Mud Hopper
53.	ea	1	Skid Mounted Mud Tank 8' x 6' x 30' (200 Barrel) with: 1 ea. Dual Shale Shaker w/screens 1 ea. Model 212 De-sander 1 ea. 4" x 10' Hose 5 ea. TRW Mission 6" Butterfly Valves 2 ea. Hale 8" Butterfly Valve 1 ea. 6" 150# RF WN Flange XH Bore 1 ea. 6" 150# RF WN Flange STD Bore 2 ea. 2" Clamps #TA100
54.	ea	2	Skid Mounted 5" x 6" Centrifugal Pumps w/471 Diesel Engines #895 No Tag
55.	ea	2	Skid Mounted 6x8 Centrifugal Pumps w/471 Diesel Engines #265, #266

SHIPPING AND ROUTING INSTRUCTIONS ________

SHIPPING WEIGHT ________ METHOD OF SHIPMENT ________

DATE SHIPPED ________ 19__

RECEIVED BY ________

SHIPPING MANIFEST

SHIPPER: BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN: GREENS BAYOU JUNE 8, 1977

AUTHORITY ______ APPROVAL ______

SHIP TO: UNITED STATES NAVY B&R JOB 03-5357

ADDRESS: OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	PAGE 4 DESCRIPTION
			MISCELLANEOUS MATERIAL
56.	ea	1	Temporary Work Deck w/40 ea. 1-1/2" S/40 Temp. Handrails 4'5-1/2", and 3 ea. Support Clamps
57.	ea	1	Grout Line A-Frame (2 pcs)
58.	ea	1	30" Rotating Scratcher
59.	ea	2	20" Centralizers
60.	ea	2	24" Centralizers
61.	ea	2	32" Centralizers
62.	LF	400	Jet Pipe 4" Drill Pipe w/Head and nozzles 13 jts.
63.	LF	400	Airlift 6" Return and 1-1/2" Airline 9 jts.
64.	ea	2	Airlift 6" Discharge Heads
65.	ea	2	Calweld Drilling Rigs on inclined Skid Bases
66.	ea	2	6" x 24' lg. Kelley Joints
67.	ea	2	6" Drill Pipe Elevators
68.	ea	4	32" Hole Opener Bits
69.	ea	3	20" Tri-Cone Bits
70.	ea	2	24" Tri-Cone Bits
71.	jts	37	6" Drill Pipe
72.	ea	3	24" OD x 24' Drill Collars
73.	ea	1	20" OD x 12' Drill Collars
74.	ea	1	16" OD x 20' Drill Collars
75.	ea	1	20" OD x 22' Drill Collars
76.	ea	2	24" OD Stabilizers
77.	ea	5	Pipe Support Forks
78.	ea	2	McKissick 3 Sheave Blocks
79.	ea	1	McKissick 2 Sheave Blocks

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT ______

DATE SHIPPED ______ 19__

RECEIVED BY ______

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 8, 19 77

AUTHORITY ______ APPROVAL ______

SHIP TO UNITED STATES NAVY B&R JOB 03-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION PAGE 5
80.	ea	2	4" 125# Crane Valves
81.	ea	2	Crown Block Assemblies
82.	ea	1	6" Pipe Flange w/lifting eye
83.	ea	2	6" Hose Clamps
84.	ea	1	6-5/8" x 432 W Pipe 30'
85.	ea	1	6" 150# RF SO Flange
86.	ea	10	6" x 50' lg. Discharge hose w/MPT Nipple each end (20 extra ends)
87.	ea	2	8" ID x 20' Suction hose w/MPT Nipples each end
88.	ea	4	2" ID x 100' Air Hose w/Boss connections
89.	ea	12	1" x 4" Steel Dowel Pins
90.	ea	12	7/8" x 4" Steel Dowel Pins
91.	ea	12	1-1/4" x 5" Steel Dowel Pins
92.	ea	120	11-441 O Rings
93.	ea	240	11-217 O Rings
94.	ea	400	3/4 x 4 A-325 HHH Bolts w/nuts
95.	ea	100	1-1/8 x 5-1/2 HHH Bolts w/nuts
96.	ea	80	7/8 x 4-1/2 A-325 HHH Bolts w/nuts
97.	ea	12	1 x 5-1/2 Blk Studs w/nuts
98.	ea	12	1-1/8 x 5-1/2 Blk Studs w/nuts
99.	ea	2	8" Model #10 Johnson Snatch Blocks
100.	ea	6	6" Fig #100 Weco Unions
101.	ea	6	2" Fig #100 Weco Unions
102.	ea	2	W58-3 Midget Weight Indicator
103.	ea	10	W-15 Fluid for Weight Indicator
104.	ea	10	Drop lights (Derrick Lighting Strings)

SHIPPING AND ROUTING INSTRUCTIONS ______

SHIPPING WEIGHT ______ METHOD OF SHIPMENT ______

DATE SHIPPED ______ 19 ___

RECEIVED BY ______

SHIPPING MANIFEST

SHIPPER: BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR — POINT OF ORIGIN: CHOLHS BAYOU — JUNE 8, 19 77

AUTHORITY ____ APPROVAL ____

SHIP TO: UNITED STATES NAVY — B&R JOB 83-5357

ADDRESS: OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	DESCRIPTION PAGE 6
105.	ea	2	5 CRC Drilling Tools Swivel
106.	ea	2	Side Inlet Oil Field Tool
107.	ea	1	16" OD x 12' Kelly Shuck
			MATERIAL ON D/B H.A. LINDSAY FOR DRILLING RIG
108.	~~ea~~	~~1~~	~~250 Barrel Water Tank~~ will be trucked to field office
109.	ea	1	1000 GPM Jet Pump
110.	ea	1	6" Fabricated Pipe Y
111.	ea	1	3" 3000# Yale Union
112.	ea	1	6" 150# RF SO Flange
113.	ea	2	1-1/4" Proto Wrench #1240
114.	ea	2	1-13/16" Proto Wrench #1258
115.	ea	2	Proto Wrench #1246
116.	ea	1	Proto 2629 SW Striking Wrench
117.	ea	1	Proto 2623 SW Striking Wrench
118.	ea	1	Proto 2620 SW Striking Wrench
119.	ea	4	1-7/16" x 1" Drive #10023 Sockets
120.	ea	4	1-1/4 x 1" Drive #10020 Sockets
121.	ea	4	1-13/16" x 1 Drive #10029 Sockets
122.	ea	2	WP620 Cleco Impact Wrench
			PAINT
123.	gal	25	Powder and Liquid Ameron Dimetcote #6
124.	gal	25	Ameron #85 White
125.	gal	25	Ameron #85 Yellow
126.	gal	10	Ameron #12 Cleaner
127.	gal	10	Ameron #6 Thinner

SHIPPING AND ROUTING INSTRUCTIONS ____

SHIPPING WEIGHT ____ METHOD OF SHIPMENT ____

DATE SHIPPED ____ 19__

RECEIVED BY ____

SHIPPING MANIFEST

SHIPPER BROWN & ROOT, INC. WESTERN HEMISPHERE MARINE CONSTR. POINT OF ORIGIN GREENS BAYOU JUNE 8, 19 77

AUTHORITY ______________ APPROVAL ______________

SHIP TO UNITED STATES NAVY B&R JOB 83-5357

ADDRESS OFFSHORE KITTY HAWK, NORTH CAROLINA

ITEM	UNIT	QUANTITY	PAGE 7 DESCRIPTION
128.	gal	10	Ameron #101 Thinner
129.	box	1	Miscellaneous material as per attached packing list. (83-5200-871)
			BARGE BUMPERS
130.	ea	16	12-3/4" x 844 Wall Top Connectors 8 @ 2'7-1/2", 8 @ 2'8-7/8"

83-5200-871

Box #1

100 ea.	3/4 x 4" Hex Hd Mach Bolts w/flat Washers & Hvy Hex nuts
1 ea.	4' x 8' Sheet 1/4" Neoprene Gasket Material
1 ea.	6" STD Weld Tee
3 ea.	6" 90 deg. LR Weld Ell Std
10 ea.	6" 150# SO Flange RF
8 ea.	1-1/2" 3000# FS 45 deg. Scr Ell
18 ea.	1-1/2 x 3 Blk XH Smls Nipple
10 ea.	1/2" x 18" Aero-quip hose
10 ea.	1-1/2" Line Pipe Coupling Blk
128 ea.	3/4 x 4 B-7 Studs & 2-2H Nuts Blk
64 ea.	3/4 x 4-1/2 Blk Studs & 2-2H Nuts
1 ea.	8" SD x 24" Dresser Coupling complete
4 ea.	6" 1000# Test Quick Stab Union w/std thrds
100 ft.	1/2" Wire Rope
18 ea.	1/2" Wire Rope Clips

SHIPPING AND ROUTING INSTRUCTIONS ______________

SHIPPING WEIGHT ______________ METHOD OF SHIPMENT BARGE HM 224

DATE SHIPPED ______________ 19___

RECEIVED BY ______________

APPENDIX D

TYPICAL TOWING SURVEYOR'S REPORT

Form 1966 Printed U.S.A.

UNITED STATES SALVAGE ASSOCIATION, INC.

14 WALL STREET NEW YORK, N. Y. 10005

CASE NO. 54-9480
INSPECTION - LOADING,
STOWING, SECURING EQUIPMENT
AND TRIP IN TOW

HOUSTON, TEXAS
JULY 6, 1977

BROWN & ROOT, INC., WESTERN HEMISPHERE MARINE CONSTRUCTION, EQUIPMENT BARGE "MM 262"

REPORT OF INSPECTION MADE BY THE UNDERSIGNED SURVEYOR OF THE UNITED STATES SALVAGE ASSOCIATION, INC. ON JUNE 10, 23 AND 24 AND JULY 5 AND 6, 1977 AT THE REQUEST OF BROWN & ROOT, INC., WESTERN HEMISPHERE MARINE CONSTRUCTION ON THE BARGE "MM 262", 2627 GROSS TONS, 298924 OFFICIAL NUMBER, BROWN & ROOT, INC., MARINE OPERATORS DIVISION, OWNERS, BROWN & ROOT, INC., WESTERN HEMISPHERE MARINE CONSTRUCTION, OPERATORS, IN ORDER TO ASCERTAIN THE SUITABILITY OF LOADING, STOWING, SECURING OF EQUIPMENT AND TRIP IN TOW OF THE TUG "KEVIN S. CANDIES" FROM HOUSTON, TEXAS TO KITTYHAWK, NORTH CAROLINA.

ATTENDING:

MESSRS. L. COWAN REPRESENTING BROWN & ROOT, INC., WESTERN HEMISPHERE MARINE CONSTRUCTION

D. ULERY REPRESENTING BROWN & ROOT, INC., WESTERN HEMISPHERE MARINE CONSTRUCTION

DESCRIPTION:

AN UNMANNED DECK CARGO BARGE BUILT OF STEEL WELDED CONSTRUCTION, BUILT BY GULFPORT SHIPBUILDING CORPORATION, PORT ARTHUR, TEXAS IN 1965. A STOCKLESS ANCHOR IS FITTED AT THE BOW AND CENTERLINE WITH APPROXIMATELY 2000' OF 1½" DIAMETER CABLE OPERATED BY A DIESEL ENGINE DRIVEN WINCH. THE BARGE IS FITTED WITH AN INTERNAL BALLASTING SYSTEM WHICH SERVES ALL COMPARTMENTS.

DIMENSIONS:

LENGTH: 250' BREADTH: 75' DEPTH: 16'

DRAFT BY LOAD LINE: 11'1¼" FREEBOARD BY LOAD LINE: 4'11-3/4"

CLASSIFICATION:

THE BARGE WAS BUILT UNDER THE SURVEILLANCE OF THE AMERICAN BUREAU OF SHIPPING AND IS ENTERED IN THE RECORD WITH THE SYMBOLS MALTESE CROSS A1 BARGE, GULF OF MEXICO SERVICE.

THE BARGE IS ASSIGNED A LOAD LINE BY THE AMERICAN BUREAU OF SHIPPING.

DRYDOCKING:

THE BARGE WAS DRYDOCKED DURING 1976, AT WHICH TIME A NEW DECK WAS INSTALLED.

FURTHER PARTICULARS CONCERNING STRUCTURAL ARRANGEMENTS AND FITTINGS ARE ON FILE IN THE HOUSTON, TEXAS OFFICE OF UNITED STATES SALVAGE ASSOCIATION, INC., IF REQUIRED.

EQUIPMENT LOADED ON BARGE "MM 262":

QUANTITY	DESCRIPTION	WEIGHT
1	JACKET #1 FOR 81' WATER, TRUE LENGTH 101'3".	145 TONS
1	JACKET #4 FOR 105' WATER, TRUE LENGTH 125'3"	185 TONS
1	DECK SUPERSTRUCTURE #1	150 TONS
1	DECK SUPERSTRUCTURE #4	150 TONS
3	42" OD PILING, 148'1" LONG, TAG P-1-1	147 TONS
3	42" OD PILING, 57' LONG, TAG P-2-1	67.5 TONS
3	42" OD PILING, 67' LONG, TAG P-3-1	85.5 TONS
3	42" OD PILING, 61'6" LONG, TAG P-4-1	79.5 TONS
3	42" OD PILING, 57'3" LONG, TAG P-2-4	73.5 TONS
3	42" OD PILING, 57'3" LONG, TAG P-3-4	73.5 TONS
3	42" OD PILING, 62'3" LONG, TAG P-4-4	79.5 TONS
3	42" OD PILING, 56'6" LONG, TAG P-5-4	72 TONS
3	33" OD PILING, 30'3" LONG, TAG P-5-1	15 TONS
14	PIECES 1" PLATE, 18-5/8" x 3'½"	
47	PIECES 1-1/8" PLATE, 18-5/8" x 3'½"	
14	PIECES 1¼" x 18-5/8 x 3'½" PLATE	
12	PIECES 1-3/8 x 18-5/8 x 3'½" PLATE.	
1	LOT SUPERSTRUCTURE HANDRAILS FOR PLATFORMS 1 AND 4	
1	LOT RIGGING ON JACKET #1 AS FOLLOWS: 1 EACH 3" x 78'10" LONG SLING; 1 EACH 3" x 73'6" LONG SLING; 3 EACH 3½" SAFETY SHACKLES	
1	LOT RIGGING ON JACKET #4 AS FOLLOWS: 1 EACH 3" x 73'6" LONG SLING	

TOTAL WEIGHT OF CARGO: 1320 SHORT TONS.

A complete shipping manifest is on file in the Houston, Texas office of United States Salvage Association, Inc., if required.

LOADING, STOWING AND SECURING ARRANGEMENTS:

Brown & Root, Inc., Naval Architecture Department, Houston, Texas prepared a Trip in Tow calculation for Barge "MM 262" loaded with 1320 short tons of deck cargo. A copy of this load out calculation is on file in the Houston, Texas office of United States Salvage Association, Inc., if required.

The barge was moored to the dock of Brown & Root, Inc., Marine O erators Division at Houston, Texas, and the equipment was loaded with crawler type motor cranes.

The units of equipment were stowed in accordance with the load out drawings and secured as outlined with pipe braces, angle steel clips and cables.

The above loading, stowing and securing was completed without incident June 24, 1977.

RECOMMENDATIONS:

1. It is recommended that it be determined that the scantlings of the vessel are such that the hull will not be overstressed in sea conditions which can be expected on the proposed voyage and that this be demonstrated by calculations carried out by a recognized consultant. A copy of the calculations to be made available to this organization. It is further recommended that the calculations reflect the existing scantlings of the vessel and that the calculations note this fact.

   The technical study should embrace statics and dynamics and should include full particulars of draft, trim, collision, rolling, pitching, heave and hull bending among waves.

   Particulars of the securing device to be determined by the consultant and the entire physical securing arrangements checked by this organization.

   Two (2) copies of determinations and calculations developed by the consultant to be made available to this organization as same are developed.

   NOTE:

   It is understood that action of this organization in this phase is limited to the formulation of the proposed character and calculations of pursuit as opposed to the checking of the propriety of calculations and approval will be so qualified.

2. The bottom chords of transverse trusses in forward rake compartment and No. 1 tank compartment position on top of the longitudinal frames filler plates are to be fitted to the transverse members between the longitudinals and extended to the bottom plate; this plate to be fully welded to bottom plating, one (1) leg of the longitudinal and the bottom chord.

3. Suitable towing pads to be installed on forward end of barge, suitably reinforced and tied into barge framing.

4. Suitable anchor to be fitted on billboard with anchor cable, approximately 300' in length, for emergency use.

5. Towing vessel to be made available for survey prior to departure of tow. A seagoing tug not to be more than 1200 horsepower. If a larger tug is used, further recommendations covering speed of advance will be issued.

6. All manhole covers to be removed, compartments opened, aired and gas freed for internal inspection. Gas free certificate stating safe for men to be issued.

7. All manhole covers and deck fittings to be made watertight. If twist-to-lock type, strongbacks to be installed to secure covers.

8. Barge to be fitted with day lights, night signals, shapes and lights as required by regulatory bodies.

9. Suitable recovery emergency tow hawser with floating pick up line to be installed on barge.

10. Engines and pump machinery located on top of cargo tanks to be protected from seas. (None fitted).

11. On completion of ballasting or loading barge for tow, waterline to be marked at each rake corner with high visibility yellow painted horizontal mark 6" wide and 48" long.

12. All tanks to be empty or full to preclude the effect of free surface liquid.

13. Vents and air escapes to be closed and made watertight except those leading to tanks containing liquids.

14. Barge to be sighted on drydock or date of last drydocking given.

15. These recommendations are preliminary in nature and additional recommendations may be issued, as found applicable, after further inspection during preparations for the voyage.

Recommendation Nos. 1 through 15 were carried out in a manner satisfactory to the undersigned prior to departure of the tow.

TUG "KEVIN S. CANDIES"

507960 Official Number 192.75 Gross Tons

The Tug "KEVIN S. CANDIES" is a twin screw all welded steel towboat with a model hull, curved stem and elliptical stern, built in Nashville, Tennessee at Nashville Bridge and Iron Works.

DIMENSIONS:

Length: 130' Breadth: 32' Depth: 19'

Light Draft: 10'5" Maximum Draft Operating: 17'

CREW:

The vessel carries a crew of seven (7) American citizens documented by the United States Coast Guard, one (1) of whom is the Master and a qualified navigator.

NAVIGATION AND COMMUNICATION EQUIPMENT:

Radio telephones consisting of single side band, VHF, AM Marine, and ADF, Loran, two (2) radars, gyro compass, magnetic compass, radio direction finder, fathometer and automatic pilot.

MACHINERY:

The main propulsion is two (2) Electro Motive diesel engines, Model 12-645-E5, each driving a single propeller through a clutch and reduction gear with a ratio of 4.5::1, total maximum brake horsepower, 4,700.

THE VESSEL IS FITTED WITH SUITABLE AUXILIARY MACHINERY FOR THE NORMAL OPERATION OF A VESSEL OF THIS SIZE AND TYPE.

ONE (1) 2" PORTABLE GASOLINE ENGINE DRIVEN PUMP WITH SUCTION AND DISCHARGE HOSE AND SPARE FUEL ON BOARD.

FUEL:

FUEL CAPACITY	120,000 GALLONS
FUEL ON BOARD	110,000 GALLONS
FUEL CONSUMED DAILY, 24 HOURS	3,000 GALLONS

TOWING EQUIPMENT:

ONE (1) TOWING MACHINE FITTED WITH 2000' OF 2" DIAMETER STEEL CABLE.
TWO (2) 1-3/4" x 90' TOWING BRIDLE CABLES.
1000' OF 12" CIRCUMFERENCE NYLON TOWING HAWSER AS SPARE.

TWO (2) 12" CIRCUMFERENCE x 250' NYLON SURGE ROPE.

NUMEROUS ITEMS OF SPARE TOWING GEAR ON BOARD.

TOWING ARRANGEMENTS:

THE TWO BRIDLE CABLES WERE ATTACHED TO HEAVY STEEL TOW PADS ON PORT AND STARBOARD SIDES OF THE BARGE AND PASSED THROUGH STEEL CLOSED CHOCKS. THE LEAD ENDS OF THE TOWING BRIDLE WERE SECURED TO THE TUGS NYLON SURGE ROPE. THE LEAD END OF THE NYLON SURGE ROPE WAS ATTACHED TO THE TUGS STEEL TOWING CABLE.

ALL CONNECTIONS WERE MADE WITH SAFETY BOLT TYPE SHACKLES WITH KEEPERS IN PLACE PRIOR TO DEPARTURE.

WHILE THE SUBJECT BARGE APPEARS TO BE OF USUAL DESIGN AND CONSTRUCTION AND BARGES OF ITS TYPE ARE NOT INFREQUENTLY USED IN SERVICE IN OPEN WATERS, IT HAS BEEN FOUND THAT SUCH BARGES MAY BE SUBJECT TO SLAMMING DAMAGE WHEN TOWED IN SUCH WATERS. NO DETERMINATION HAS BEEN MADE BY THIS ASSOCIATION AS TO THE INHERENT STRUCTURAL INTEGRITY AND STRENGTH OF THE SUBJECT BARGE AND NO OPINION IS EXPRESSED WITH RESPECT TO ITS ABILITY TO WITHSTAND THE SLAMMING FORCES TO WHICH IT MAY BE SUBJECTED DURING TOWAGE.

THE UNITS COMPRISING THIS TOW HAVE BEEN CAREFULLY INSPECTED AFLOAT AS FAR AS PERMISSIBLE AND THE LOADING, SECURING, THE UNITS AND CONNECTIONS ONE TO THE OTHER AND THE PROCEDURES OUTLINED FOR THE TOW, IN THE OPINION OF THE UNDERSIGNED AS HEREINAFTER QUALIFIED, WILL BE SATISFACTORY FOR THE TOW TO SAFELY CONCLUDE THE PROPOSED TRIP WITH WEATHER AND SEA CONDITIONS NORMALLY TO BE EXPECTED ON THE VOYAGE FROM HOUSTON, TEXAS TO OFFSHORE KITTYHAWK, NORTH CAROLINA, DEPARTING AT 0745 HOURS JULY 6, 1977. THE LOCAL OFFICE OF THE UNITED STATES WEATHER BUREAU ADVISED THAT NORMAL WEATHER CONDITIONS PREVAILED AT THE POINT OF DEPARTURE.

THIS EXAMINATION HAS BEEN MADE WITHOUT MAKING REMOVALS, OPENING UP TO EXPOSE PARTS ORDINARILY CONCEALED, TESTING FOR TIGHTNESS OR TRYIN OUT MACHINERY AND IS SUBJECT TO ANY CONDITIONS WHICH WOULD HAVE BEEN REVEALED IF SUCH PROCEDURES HAD BEEN ACCOMPLISHED.

THE ABOVE OPINION IS BASED ON THE ASSUMPTION THAT CALCULATIONS PERFORMED BY OTHERS ARE IN ORDER AND THE OPINION SHOULD NOT BE CONSTRUED AS A CHECK BY THIS ORGANIZATION OF THOSE CALCULATIONS.

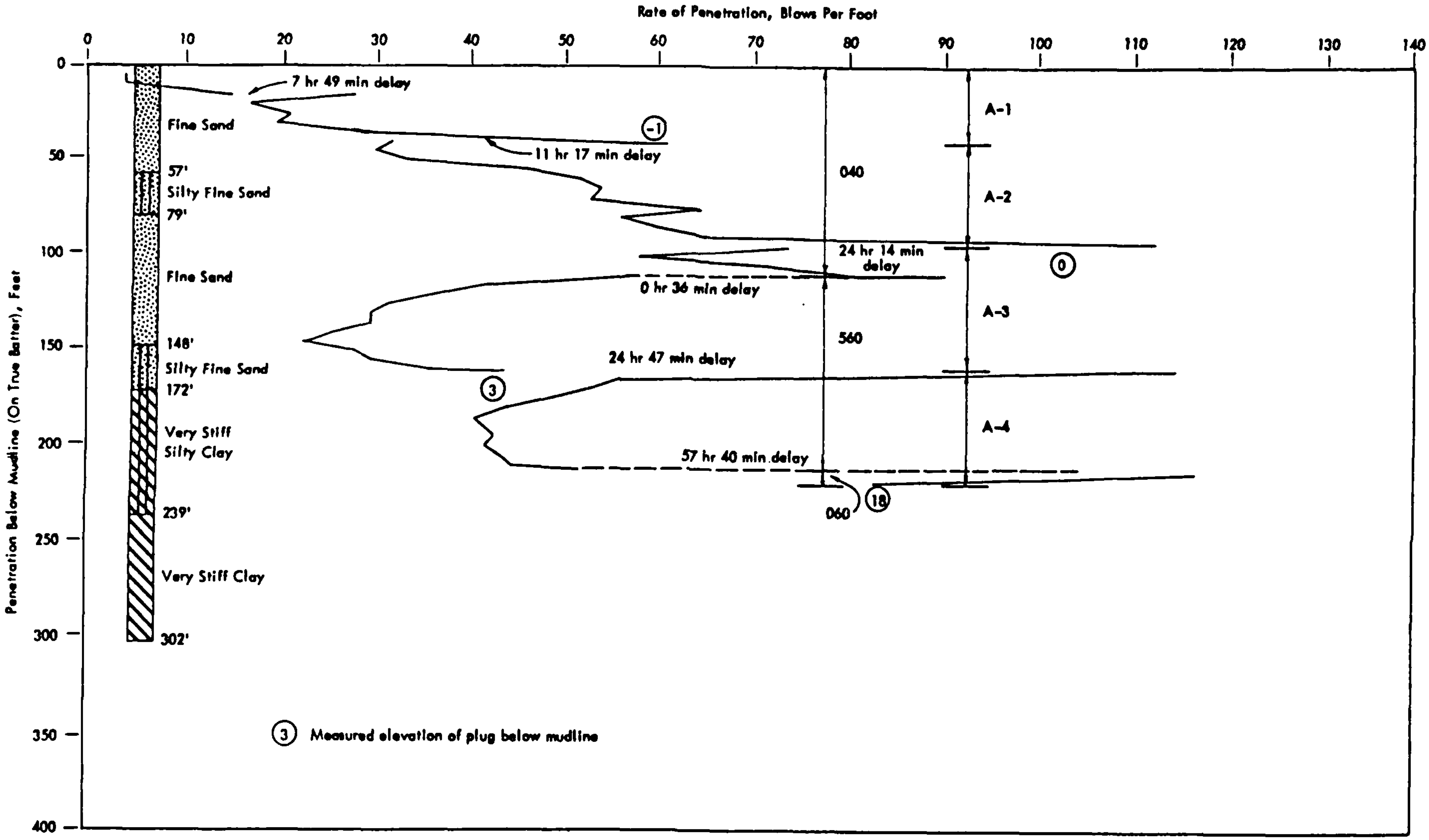
INSPECTION MADE WITHOUT PREJUDICE.

W. R. ORANGE
RESIDENT SURVEYOR

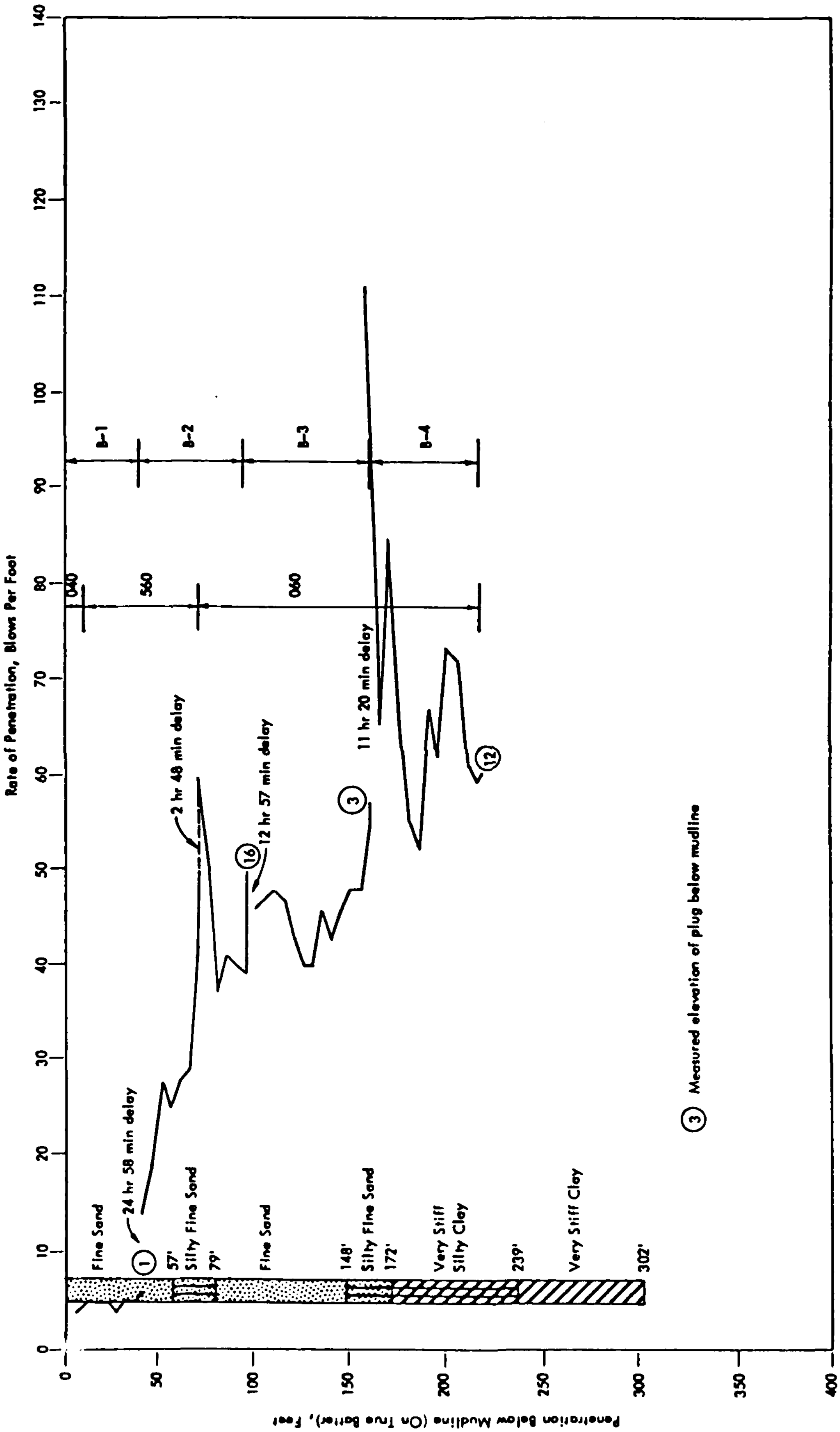
WRO/MN

APPENDIX E

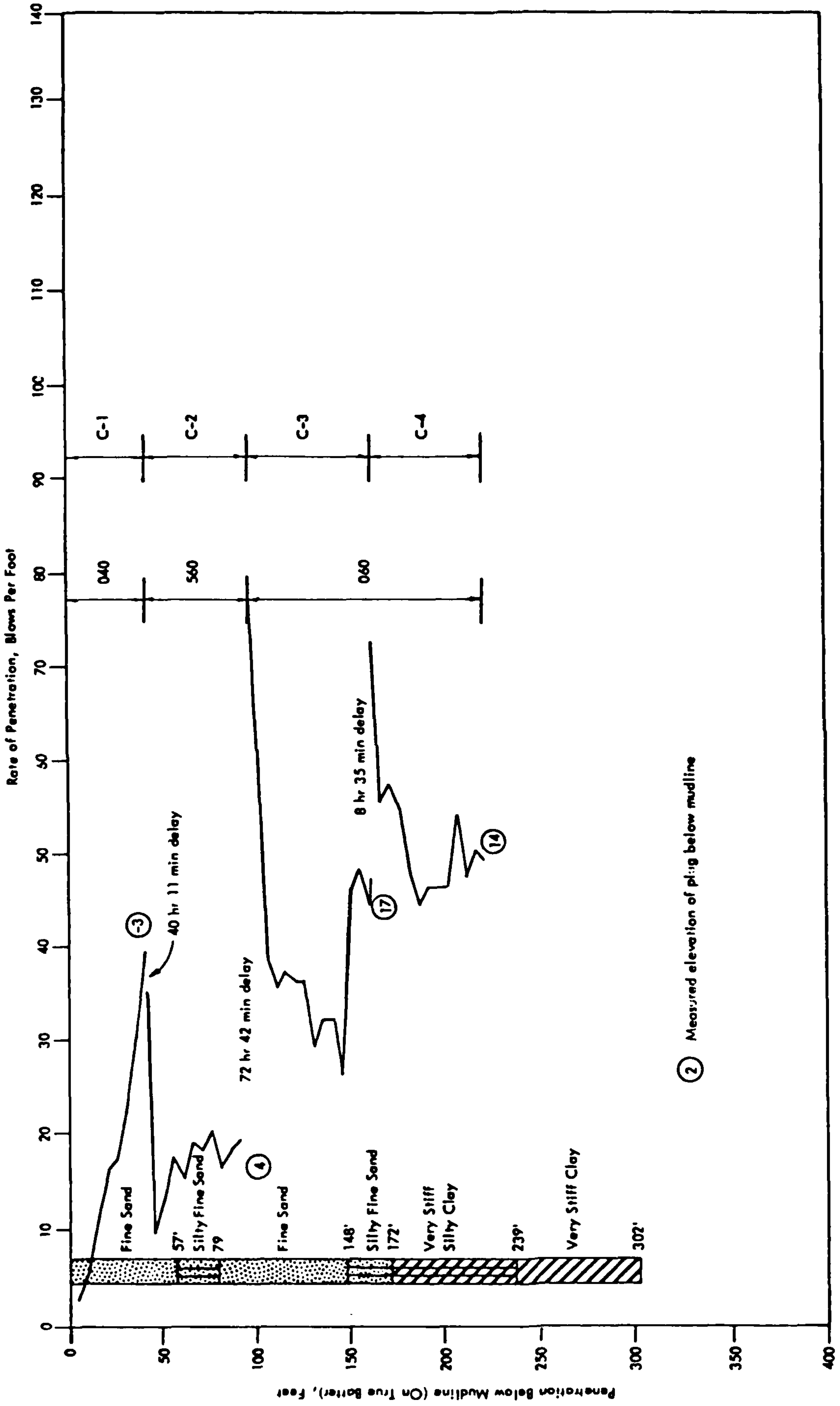
PILE DRIVE LOG RECORDS



BLOW COUNT RECORD
Platform 1, Pile A

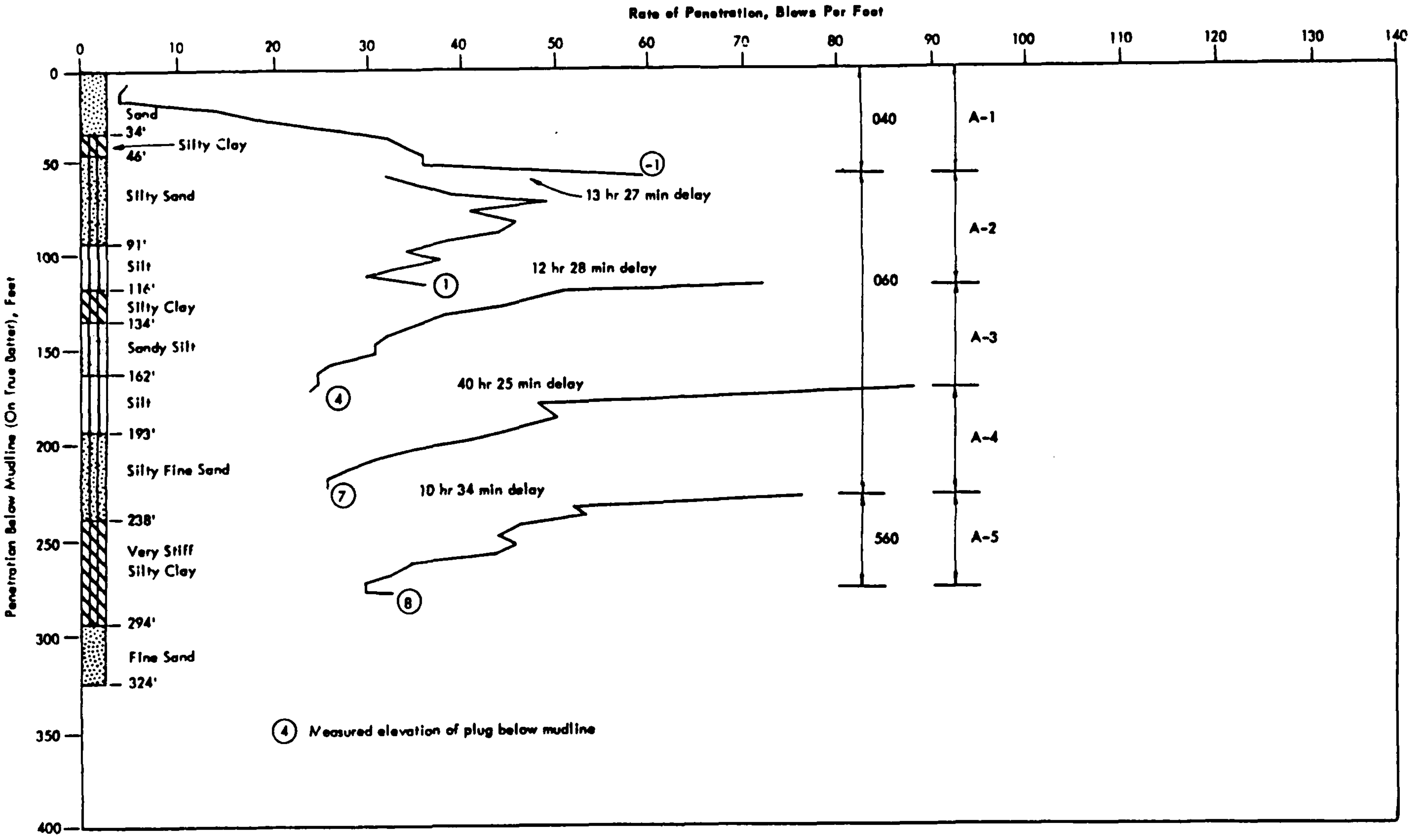


BLOW COUNT RECORD
Platform 1, Pile B

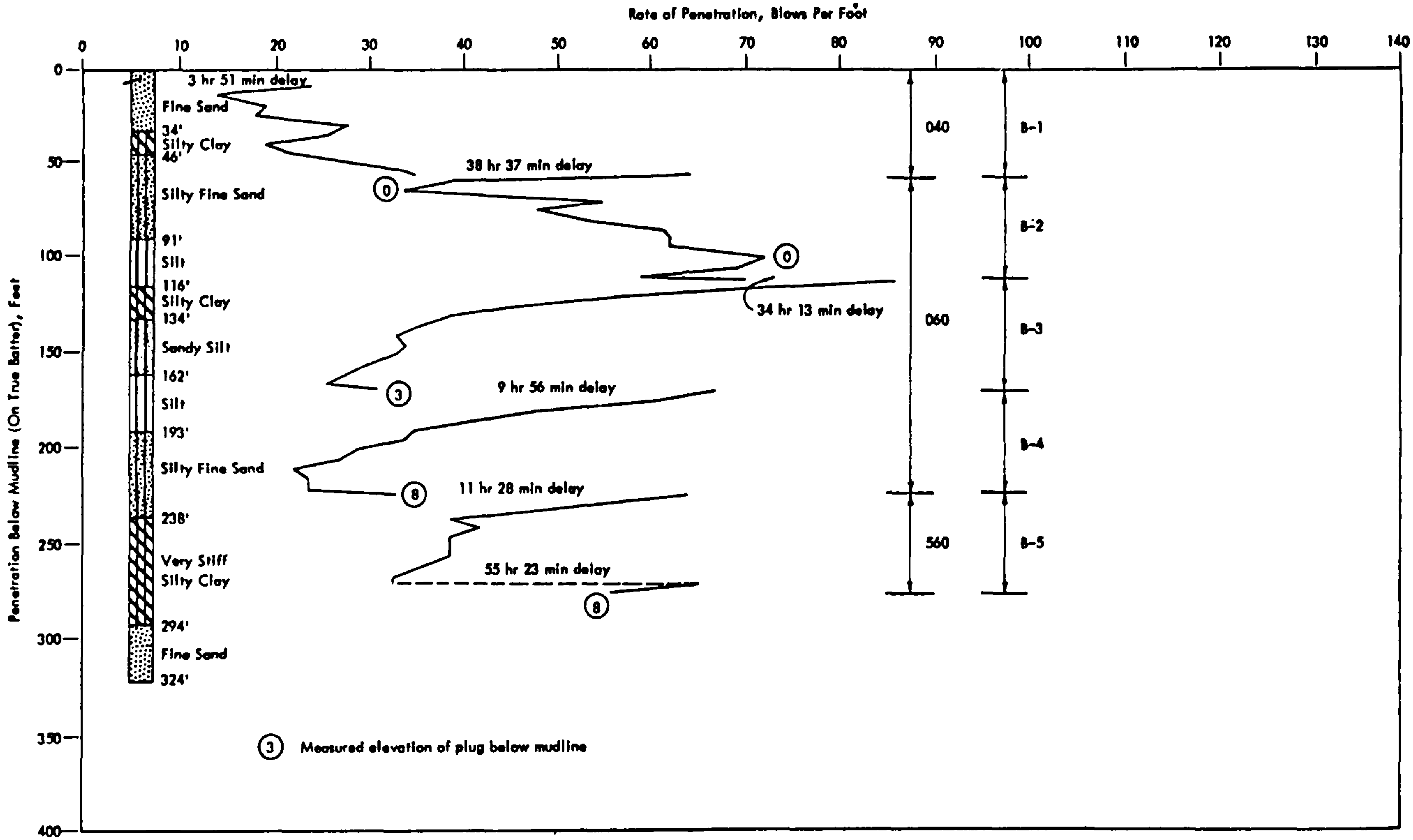


BLOW COUNT RECORD
Platform 1, Pile C

PLATE 3

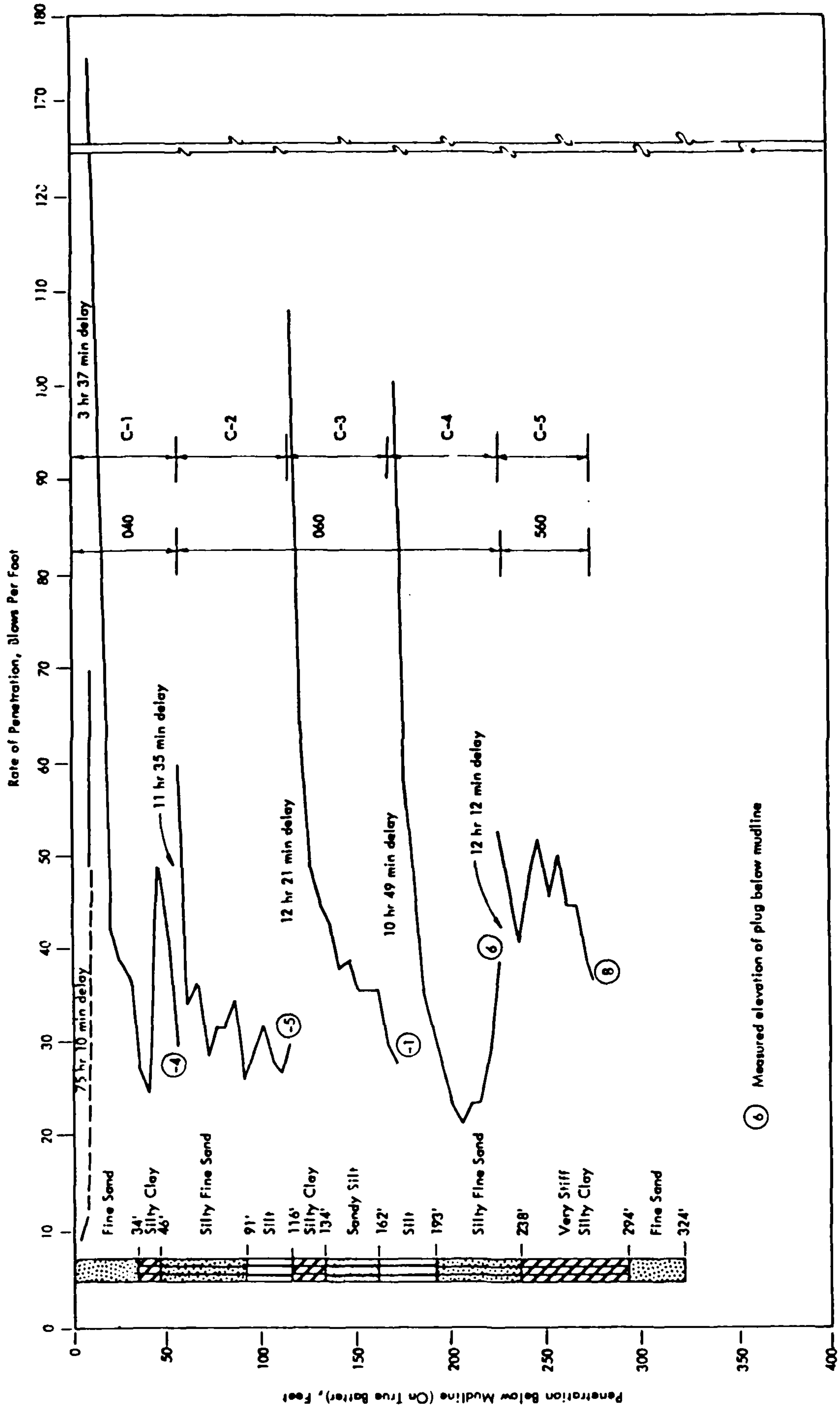


BLOW COUNT RECORD
Platform 2, Pile A

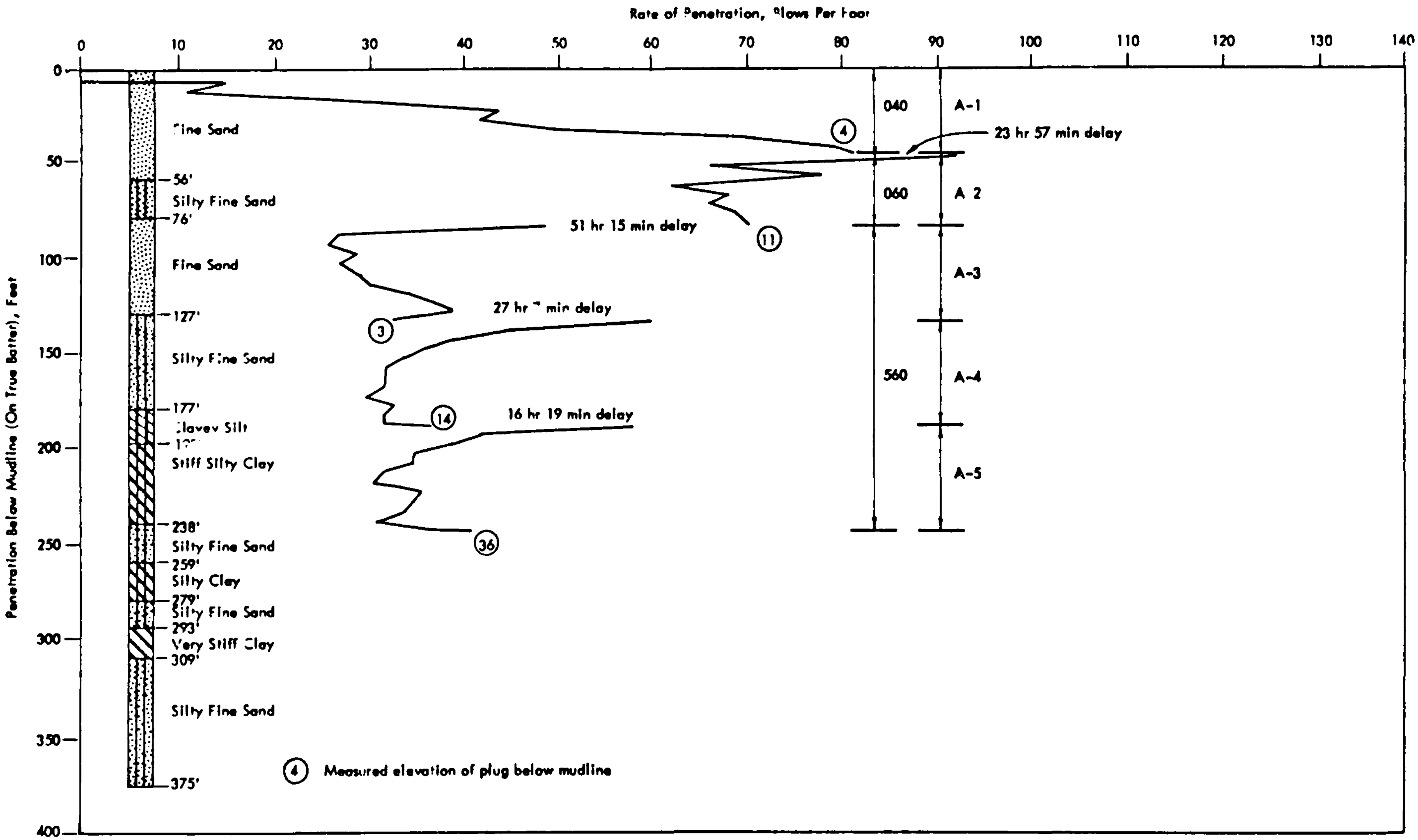


BLOW COUNT RECORD
Platform 2, Pile B

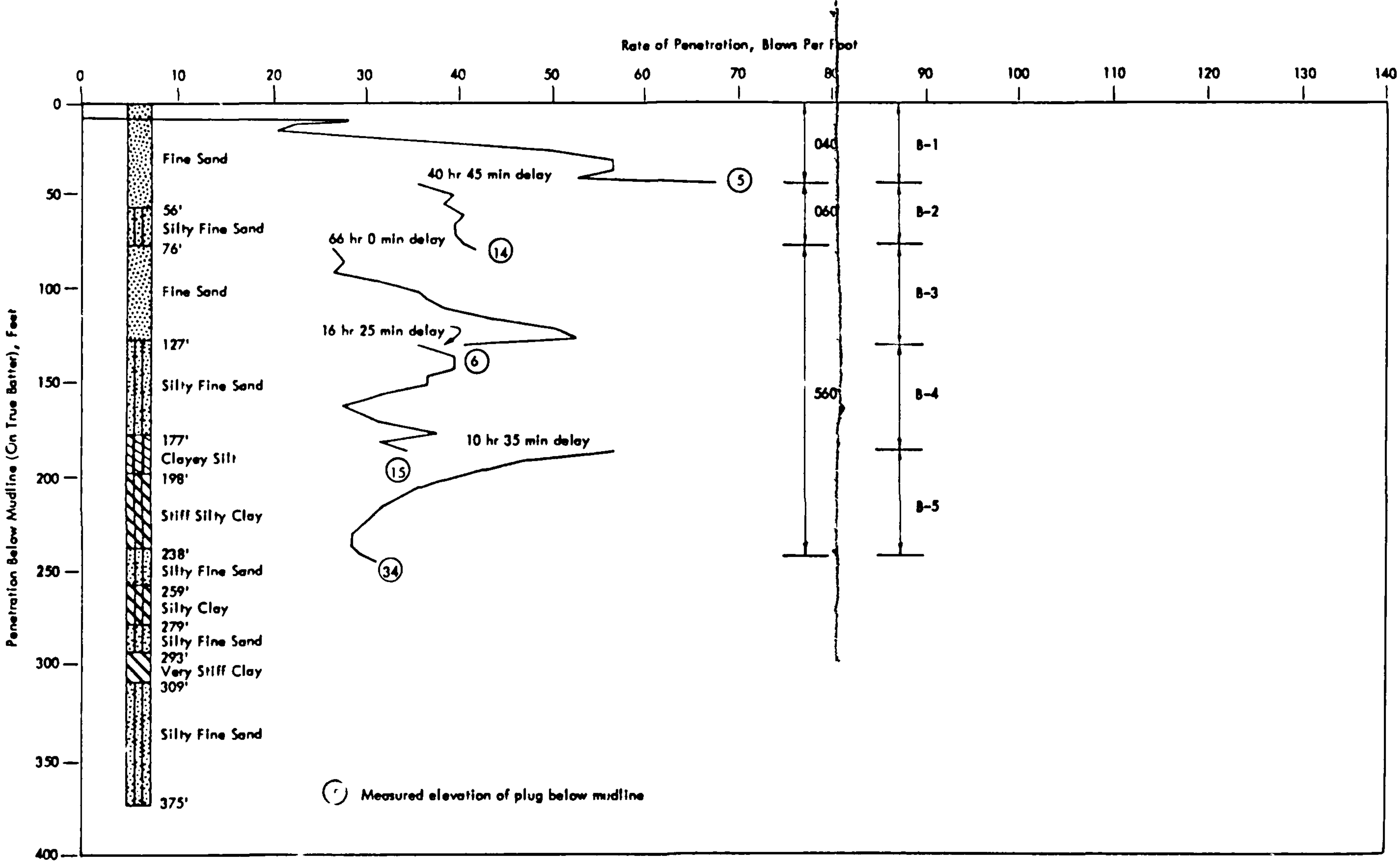
PLATE 5



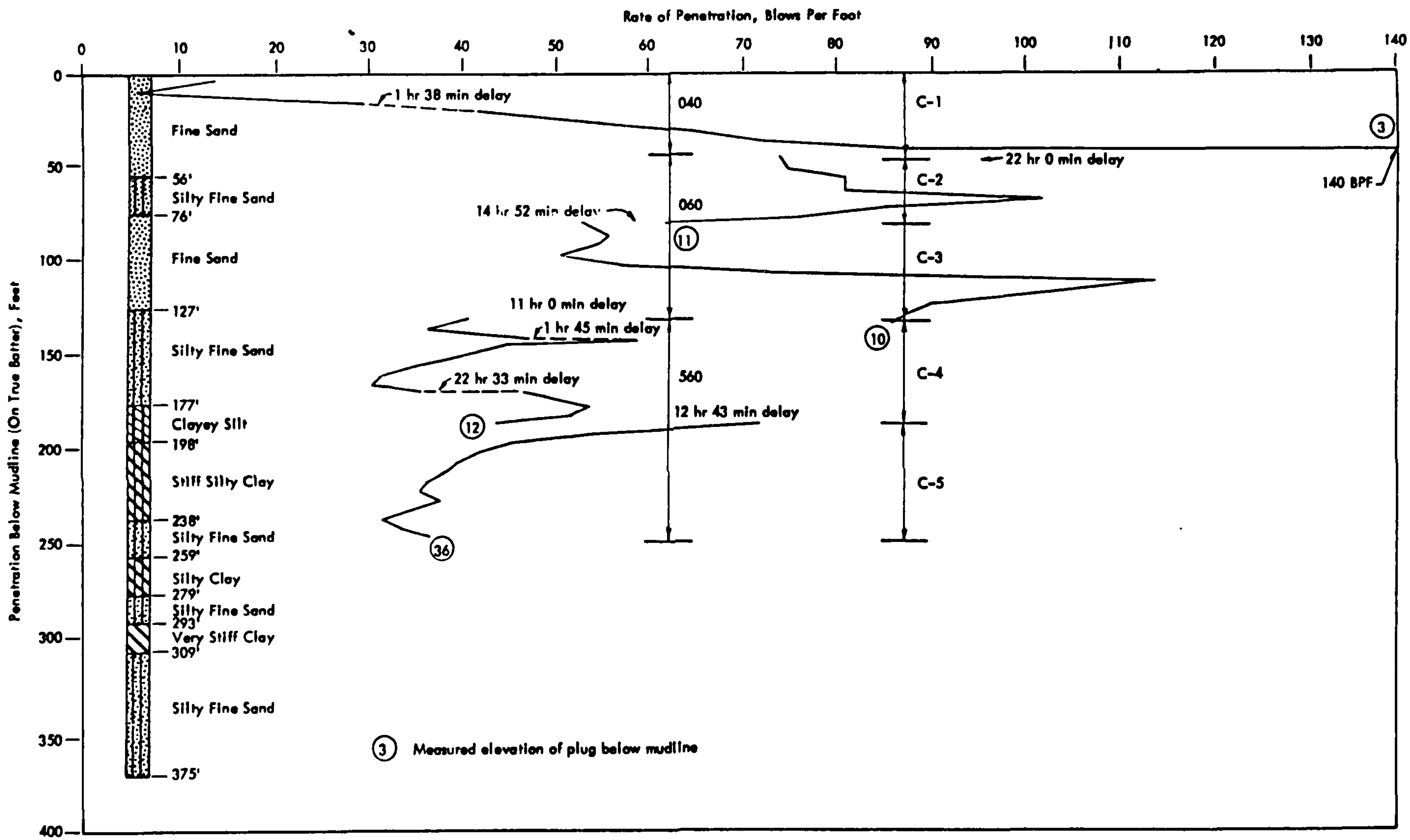
BLOW COUNT RECORD
Platform 2, Pile C



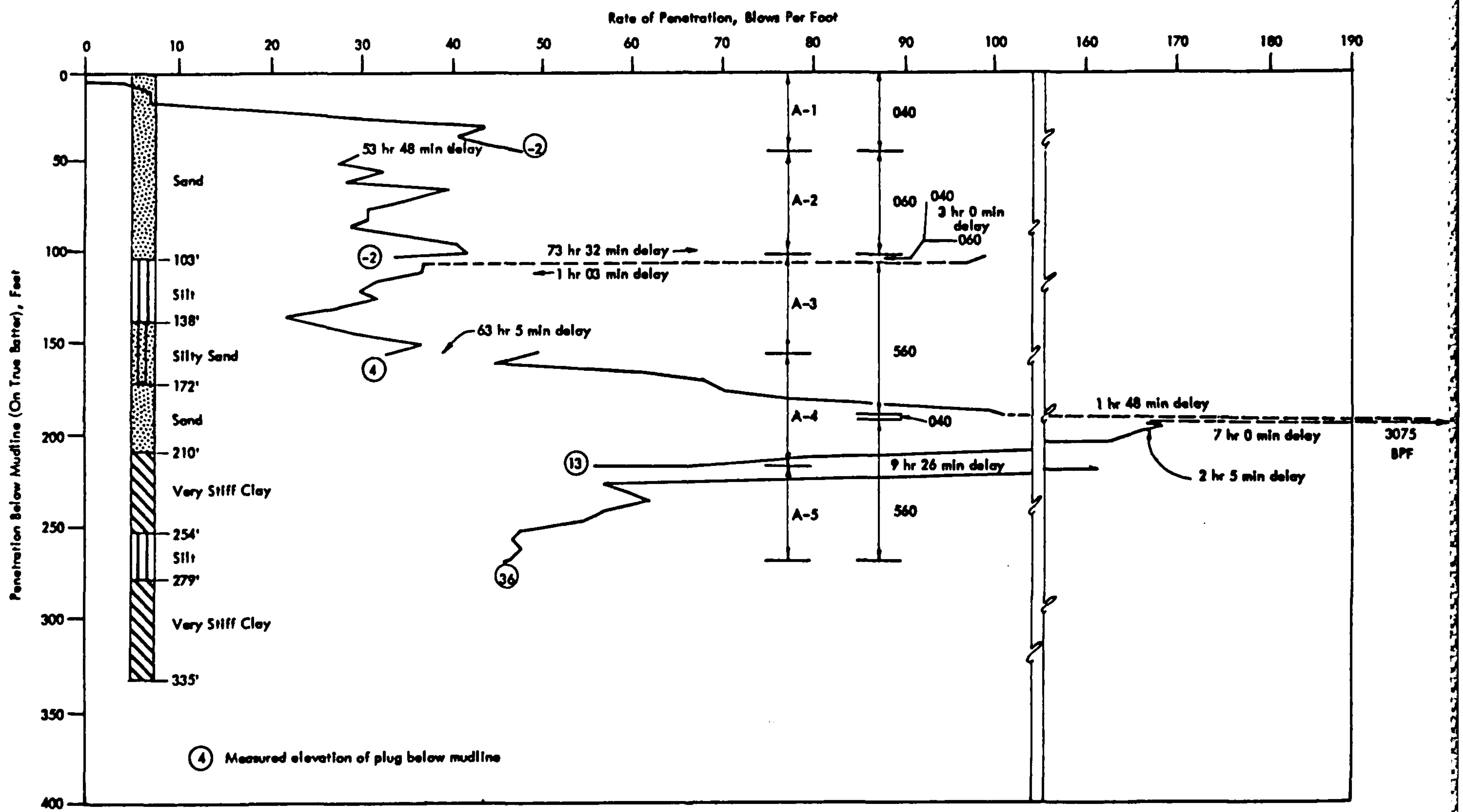
BLOW COUNT RECORD
Platform 3, Pile A



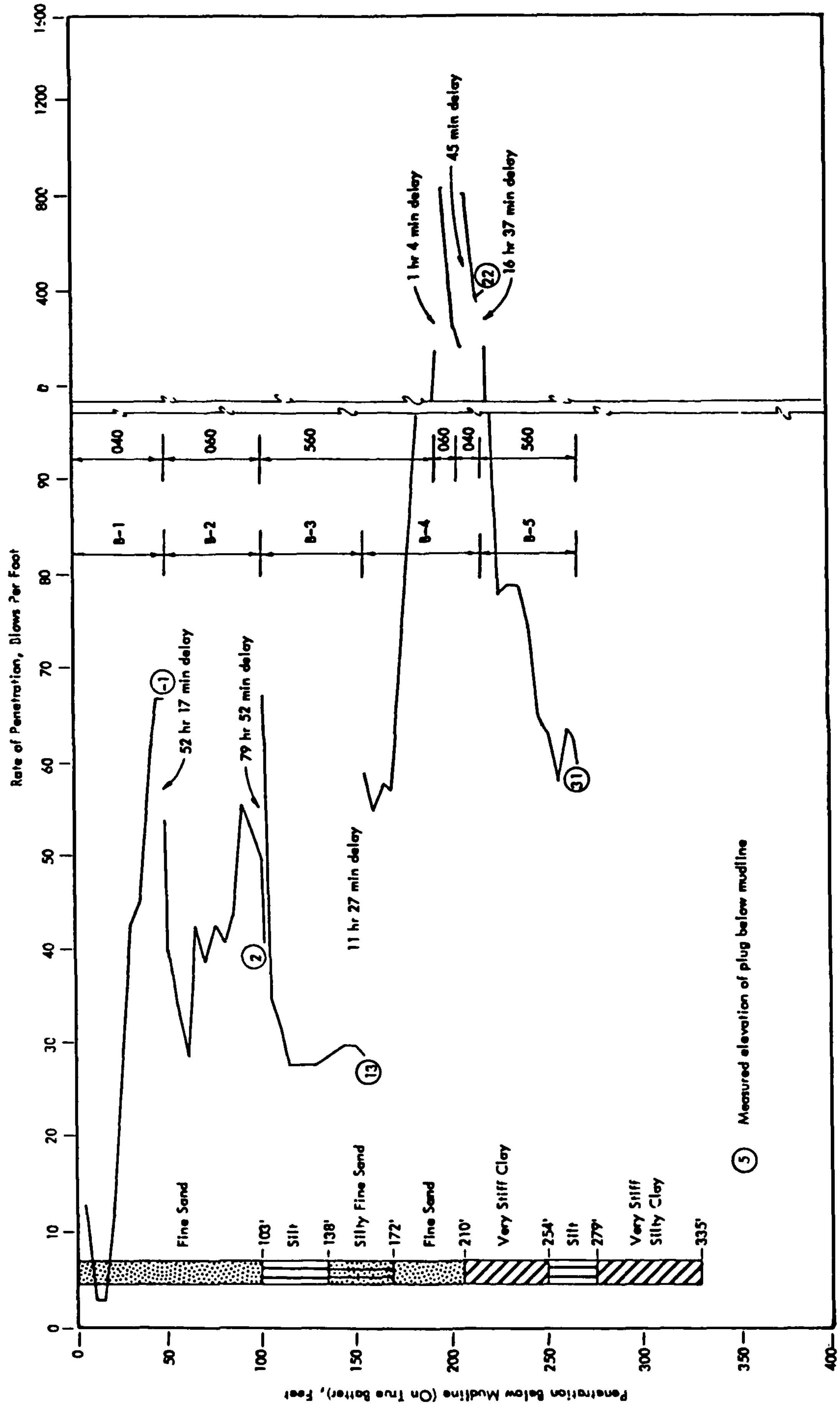
BLOW COUNT RECORD
Platform 3, Pile B



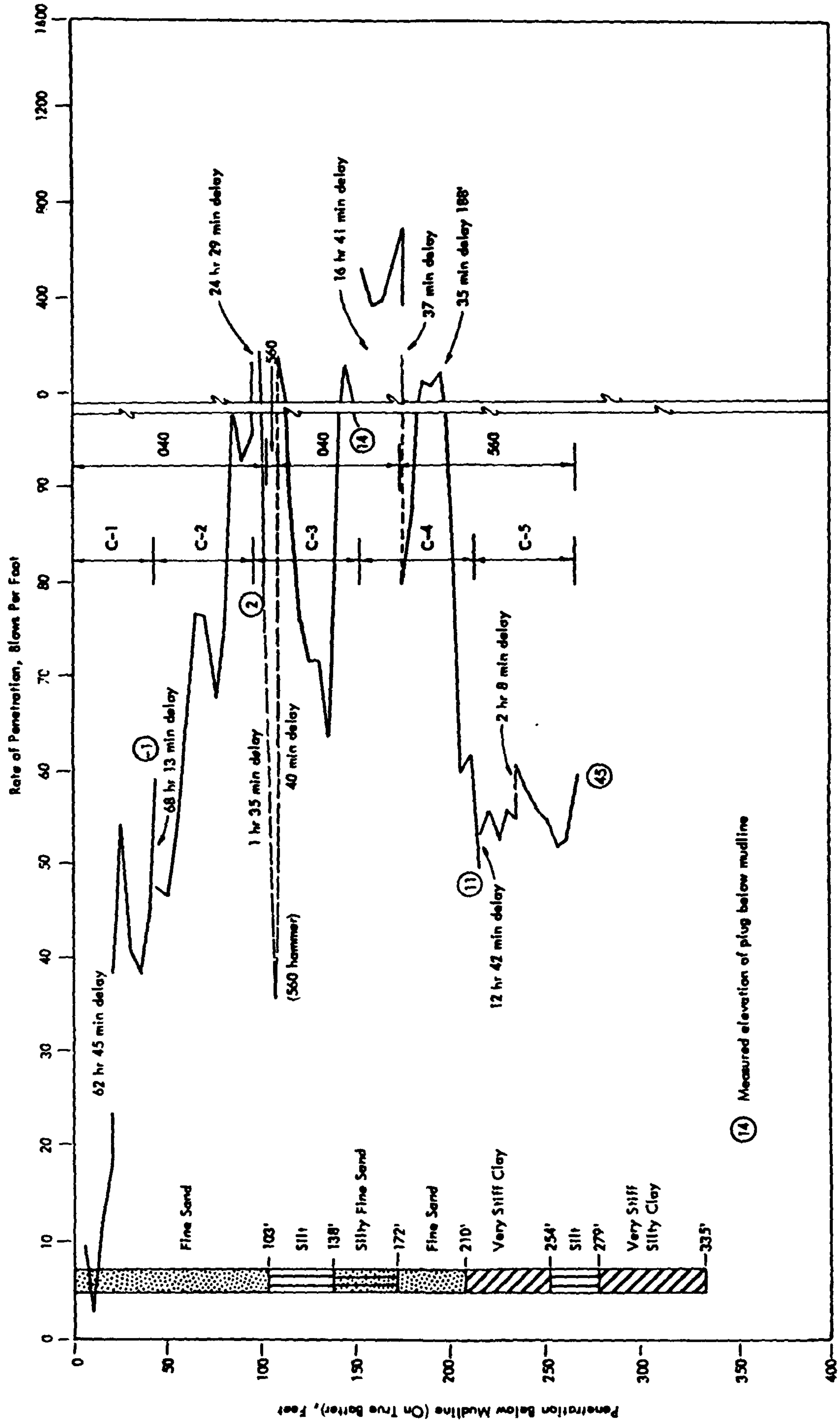
BLOW COUNT RECORD
Platform 3, Pile C



BLOW COUNT RECORD
Platform 4, Pile A



BLOW COUNT RECORD
Platform 4, Pile B



BLOW COUNT RECORD
Platform 4, Pile C

APPENDIX F

ROICC SITUATION REPORTS

DTG: 271200Z
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 22A
1. SITUATION FOR PERIOD 25-26 June 77 AS FOLLOWS:

A. WEATHER - Wind S-S.W., 10-20 Knots
No Rain
Seas 0-1 Ft.
Swells 2-5 Ft.
B. ADMIN - LCDR Cullison to Shore 25 June
LT Mayer Off Shore 25 June
C. OPERATIONS - 24 June Jacket #2 Placed
25 June 1st Section of each pile stabbed
Pile 1B driven 58 feet
Blows per foot range 1-38 per foot
Average blows 21 per foot
26 June Attempted to level jacket; 6-12" difference between legs; attempt unsuccesful

D. EQUIP STATUS - Minor damage to 040 pile driving hammer - since repaired.

E. LOGISTICS - Food and accommodations excellent

F. TRAINING - No report

G. SAFETY - No accidents

H. MEDICAL - AREICC, C&C Rep, and approx 5 crew members with virus.
Prognosis for full recovery excellent

I. MORALE - Good

2. LT, MAYER, ROICC ACMR, SENDS.

DTG:
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 23
1. SITUATION FOR PERIOD 27 June - 4 July AS FOLLOWS:

A. WEATHER - Generally very good - skies have been clear to partly cloudy; air temperatures from a high of 95° (day) to a low of 70° (night). Winds have been variable from NE to SW, generally from 5-20 knots, reaching a maximum of 35 knots during a thunder storm. Sea conditions were very good with swells coming from the SE-SW, 1-3 feet high, 5-7 seconds period. Only during a 12 hour period associated with an electrical storm were meteorological and sea (seas/swell combined to 3-6 ft) conditions severe enough to discontinue construction operations.

B. ADMIN - George Anadale, CHESDIV 0511, visited installation site for tower #2 during the period 27-29 June to monitor/inspect construction activity:

C. OPERATIONS - After eight days of pile driving, the contractor had succeeded in driving piles approximately 273 feet below the sea bottom through each of the three jacket legs. The superstructure was then placed atop the three piles. By week's end, the boat landing, fenders, navaids and solar panels were in place and operating, and welders were completing the shim connections between superstructure and jacket.

D. EQUIP STATUS - The anxilliary boiler, used to power the larger pile-driving hammers, remained operational just long enough to drive the last of tower #2's piles. It is now under repair and should be available for tower #3's piles. Although less efficient, the derrick barges main boiler could be used to power the hammers.

E. LOGISTICS - no report

F. TRAINING - no report

G. SAFETY - no accidents

H. MEDICAL - one crew member injured abdominal muscles during rigging operations.

I. MORALE - very high with visions of tower #2's completion.

2. LT, MAYER, ROICC ACMR, SENDS.

Copy to: 09...09A...09A2...05...FPO-1...1EA...1C1...02...ROICC...AREICC(3)...
AROICC...

DTG: 290500Z JUNE 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 23A
1. SITUATION FOR PERIOD 27,28 June 1977 AS FOLLOWS:

A. WEATHER: Partly Cloudy to Cloudy
Winds : S - S.E. 10-15 and 20-25 MPH
Seas : Less than 1 foot and 1-3 feet
Swells : S - S.E., Size 2-3 feet variable periods

B. ADMIN : George Anadale (Code 0511) arrived on site 1700 - 27 June. Scheduled to depart 29 June.

C. * OPERATIONS : 27 June- 1. Pile B-2 Driven 55 ft w/060 Hammer, BPF 31-80, Average 58
28 June- 1. Pile B-3 Driven 57 ft w/060 Hammer, BPF 25-63, Average 35
2. Pile B-4 Driven 55 ft w/060 Hammer, BPF 21-60, Average 31
Planned Operation - Complete Pile B (B5)
Drive A and C Pile in following sequence: Class A-1, C-1, A-2, C-2, A-3, C-3, A-4, A-5, C-4, C-5

D. EQUIP STATUS : No Report

E. LOGISTICS : No Report

F. TRAINING : None

G. SAFETY : No accidents

H. MEDICAL : Majority of patients recovered from virus. 1 crew member taken to local hospital w/same symptoms.

I. MORALE : Much Improved w/pile driving success

2. LT, MAYER, ROICC ACMR, SENDS.

3. Note - SITREP #22A reported 6-12" elevation difference between jacket legs. Jacket has since leveled itself to within 3" between legs during driving of Pile B.

* Total footage for pile B is 224 to date.

DTG: 010500Z JUL
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO.23B
1. SITUATION FOR PERIOD 29-30 June AS FOLLOWS:

A. WEATHER:
Seas: $1\frac{1}{2}$ - 2 feet
Swells:S.W. 1.5 - 3.5 high, 5-6 seconds

B. ADMIN: George Anadale departed 29 June 1977

C. OPERATIONS:

DATE	PILE SECTION	FOOTAGE	HAMMER	BPM	BPF	AVER
29 Jun	B5	40	560	40	46-31	38
29 Jun	C1	56	040	53	57-22	36
29 Jun	A1	54	040	53	2-74	35
30 Jun	C2	57	060	57	56-24	31
30 Jun	A2	59	060	57	55-30	36
30 Jun	C3	56	060	56	66-26	40
30 Jun	A3	55	060	57	56-23	33
30 Jun	C4	55	060	58	50-16	33

D. EQUIP STATUS: NONE

E. LOGISTICS: NONE

F. TRAINING: NONE

G. SAFETY: NONE

H. MEDICAL: NONE

I. MORALE: Very Good

2. LT, MAYER, ROICC ACMR, SENDS.
3. Driving of Pile C-1 caused jacket to tilt 6" at Leg C. Legs A and B are level within 1" of each other. No significant improvement during subsequent driving. Corrective measures being considered.

DTG: 050500Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 23C
1. SITUATION FOR PERIOD 1 - 4 Jul 77 AS FOLLOWS:

A. WEATHER - General: Skies Clear to Partly Cloudy
Winds : E - N.E. 5-15 Knots
Seas : $\frac{1}{2}$ - 1 Ft.
Swells : From South 1-3 Ft, 6-7 seconds

B. ~~ADMIN~~ None
During Electrical storm; winds S.W. 20-35 knots. Rain moderate to heavy w/lightening; seas and swells combined 3-6 feet. Construction operations discontinued 12+ hours.

C. OPERATIONS
1 Jul - Pile C-5 driven 48 ft w/560 at 40 BPM; BPF range 57-37 Av. 48.
Pile B-5 driven additional 5 ft w/560 at 40 BPM; BPF range 56-65 Av. 60.
Electrical Storm shuts down construction operations at 1900Q.
2 Jul - Construction Operations resume at 0715.
Pile A-4 driven 55 ft w/060 at 57 BPM; BPF range 57-24 Av. 34.
Pile A-5 driven 49 ft w/560 at 39 BPM; BPF range 57-26 Av 41.
3 Jul - Superstructure, boat landing and fenders in place.
4 Jul - Weldout of pile, jacket and superstructure connections; NAVAIDS, batteries, and solar panels in place.

PUMP ??? TOWER LEVEL

D. EQUIP STATUS : None

E. LOGISTICS : None

F. TRAINING: None

G. SAFETY: None

H. MEDICAL: One crew member strained back lifting pad eye.

I. MORALE: High

2. LT, MAYER, ROICC ACMR, SENDS.

DTG:
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 24
1. SITUATION FOR PERIOD 5-10 July 1977 AS FOLLOWS:

A. WEATHER: Generally good - skies were clear, but changed to partly cloudy and overcast by week's end. Winds were variable 0-20 knots. Electrical storms accompanied by heavy rains and high winds postponed construction operations six hours. Sea conditions were a mix of wind-driven waves (seas) and swell; the swell was generally from the south 1-3 feet high, 3-6 sec period; swell was occassionally masked by seas as high as three feet.

B. ADMIN: Mr. MacCallum replaced Mr. J. McCann as one of the two QA representatives

C. OPERATIONS: Except for a few, minor punch list items, the contractor completed construction of Tower #2 and moved on to Tower 3's installation site. Subsequent to a location and hydrographic survey, the contractor placed and oriented the jacket of Tower 3 in 106.5 feet of water (within acceptable design tolerance). By week's end, he had driven piling 76, 77, and 129 feet in jacket legs A, B, and C, respectively. The final design penetration is 240 feet in each leg. UCT ONE was to have performed a government's underwater inspection survey of the completed Tower 2 installation. The survey was postponed when one member of the survey team was injured in a mooring associated accident.

D. EQUIP STATUS: The contractor's anxilliary boiler was returned on-line by 10 July, in time for driving pile C-3 to 129 feet. The derrick barge's mainboiler had been used up to that time for Tower 3 pile driving.

E. LOGISTICS: Mail delivery to ROICC personnel aboard the derrick barge LINDSAY may be better effected by Hand-carrry messenger. Prior to forwarding mail by U.S. Postage, check with 09A5 if any CHESDIV representatives are scheduled to visit the construction site.

F. TRAINING: NO REPORT

G. SAFETY: At government's request, project manager discussed with barge foreman and supervisors the importance and responsibility for safety. Each foreman and supervisor emphasized same with their crews.

H. MEDICAL: Contractor foreman pulled a muscle about his rib cage while assisting member of his crew in rigging operations. One member of UCT ONE injured during mooring operations for diver inspection.

I. MORALE: Relationships between government personnel and crew members temporarily strained due to government's request for greater safety emphasis. (see G above).

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to: 09..09A..09A2..05..02..FPO-1..FPO-1C1..1EA..ROICC..AREICC(3)..AROICC...
FC-2..

DTG: 080600Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 24A
1. SITUATION FOR PERIOD 5-8 July 1977 AS FOLLOWS:

A. WEATHER : General-Skies Clear to Partly Cloudy; Winds from West 5-15 Knots; Seas 0-1 feet; Swells from South 1-3 feet, 3-5 seconds period.

B. ADMIN - UCT Divers aboard SEACON - arrived Site #2 at 071200Z July 77.

C. OPERATIONS

5 July - Weldout of pile jacket and superstructure connections.

6 July - Contractor's Diver Inspection - No damage reported; sandblasting and painting of superstructure; location survey and preparation for jacket #3 installation.

7 July - Final paint coat. Contractor departed for Site #3 at 1400 local. Jacket #3 placed in 106.5 feet of water.

8 - 10 July - Planned Operations: Stab and drive initial 2 Sections of each pile; then drive piling in one leg to designed depth as test pile.

D. EQUIP STATUS - NONE

E. LOGISTICS - NONE

F. TRAINING - NONE

G. SAFETY - See Medical

H. MEDICAL - 1 contractor person pulled muscle of rib cage during rigging. 1 UCT person reported injured during rigging operations at Site #2.

I. MORALE - NONE

2. LT, MAYER, ROICC ACMR, SENDS.
3. Top Side Inspection reveals following: a. Damaged crane casting. b. missing 5 solar panel section. c. contractor taking action to repair crane. d. missing panels at manufacturer for repair. e. panels do not effect NAVAIDS. f. NAVAIDS are operational.

Copy to: 09...09A...02...05...09A2...FPO-1...1C1...1EA...PC-2...ROICC...AREICC...AROICC...

DTG: 110500Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 24B
1. SITUATION FOR PERIOD 8-10 JUL 77 AS FOLLOWS:

A. WEATHER : Generally Partly Cloudy to Overcast w/Fog
Winds : Variable 10-20 knots
Seas : 0-3 Ft
Swells : From South 1-3 Ft, 5-6 second periods, occasionally masked by local Sea conditions. Electrical Storm activity w/gusts to 63 MPH and heavy rains delayed construction operations 6 hours.

B. ~~XXXXX~~

B. ADMIN : D. McCullum replaced J. McCann as QA Rep on 7 July.

C. OPERATIONS :
Operations at Tower #3 Site: 8 JUL - Pile B1 driven 42 ft w/040 at 57 BPM; AV 51 BPF. Pile A1 driven 43 ft w/040 at 54 BPM; AV 59 BPF. Pile C1 driven 42 ft w/040 at 50 BPM; AV 63 BPF, 140 MAX.

9 JUL - Electrical storm shuts down contractors operations from 0230-0830. Pile C2 driven 37 ft w/060 at 45 BPM; AV 78 BPF, 123 MAX. Pile A2 driven 36 ft w/060 at 52 BPM; AV 70 BPF.

10 JUL - Pile C-3 driven 50 ft w/060 at 54 BPM; AV 77 BPF, 118 MAX. Pile B2 driven 36 ft w/060 at 54 BPM; AV 40 BPF, consistant throughout.

D. EQUIP STATUS : NONE

E. LOGISTICS: NONE

F. TRAINING : NONE

G. SAFETY - Contractor held supervisor safety meeting

H. MEDICAL- No injuries, no serious disease.

I. MORALE - Very good

2. LT, MAYER, ROICC ACMR, SENDS.

DTG: 130500Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 25A
1. SITUATION FOR PERIOD 11-12 July 1977 AS FOLLOWS:

A. WEATHER - Skies - Clear to partly cloudy
Winds - From SE 10-20 knots;
Seas - 1-3 ft; dual sweels 3-6 ft from NE, 5-6 seconds; and 2-4 ft from ESE, 3-4 seconds; max combined height 6 ft. Combined swell condition caused pile driving operations to be post-poned for 16 hours.

B. ADMIN - Mr. Tabt relieved Mr. Collins as one of the two QA representatives on 11 July. PH3 Fcbrou, FLTAVCOMLANT, arrived 11 July for film documentation of ACMR construction.

C. OPERATIONS

11 July - Pile C-4 driven 37 ft with 560 at 40 BPM, average 37 BPF; when 560 hammer failed (6AM). Hammer was repaired as of 11AM, but combined winds and swell conditions caused excessive pitching and rolling of derrick barge. *Operations could not be resumed remainder of day.*

12 July - Contractor off weather hours 3AM. Pile C-4 driven 17 additional feet with 560 at 39 BPM, average 52 BPF. Pile A-3 driven 50 feet with 560 at 48 BPM average 31 BPF. Pile C-5 driven 59 feet with 560 at 40 BPM, average 39 BPF.

13 - 14 July - Plans include completion of pile driving and preparations for superstructure.

D. EQUIP STATUS - Ram Keeper Pins broke loose from 560 hammer during operations; since repaired.

E. LOGISTICS - no report

F. TRAINING - no report

G. SAFETY - no accidents

H. MEDICAL - no report

I. MORALE - good

2. LT, MAYER, ROICC ACMR, SENDS.
3. Jacket out of level by 6-8 inches as result of pile driving. Contractor considering corrective measures.

4. Late Entry. Contractor divers reported jacket #2 mudline brace two ~~figures~~ feet above mudline during last week's inspection.

Copy to: 09...09A...02...05...09A2...FPO-1...1C1...1EA...PC-2...ROICC...AREICC...AROIC

DTG: 150400Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO.25B
1. SITUATION FOR PERIOD 13-14 JUL 1977 AS FOLLOWS:

A. WEATHER-Clear skies; Winds SSE 5 knots and North 7 knots; Seas 1-2 feet and 0-½ feet, respectively. Swells 1-2 feet 3-4 second period, from SE on the 13 and from the W on the 14th.

B. ADMIN- Tub Kevin Candies with Mr. Masso aboard and Towing Barge with Towers 1 and 4, arrived at Tower #3 Installation Site 13 July (AM)

C. OPERATIONS - 13 July - Pile A-4 Driven 57 ft with 560 at 40 BPM; AV 34 BPF. Pile B3 driven 54 ft with 560 at 44 BPM; AV 38 BPF.
14 July - Pile A5 driven 55 ft. with 560 at 39 BPM; AV 35 BPF; Penetration depth 241. Pile B4 driven 52 ft. with 560 at 40 BPM AV 35 BPF. Pile B5 driven 58 ft with 560 at 40 BPM; AV 34 BPF; Penetration depth 242 ft. using 100 ton jacks braced by piles A&C, Contractor improved level condition to within 6 inches at days end.
15 - 17 July - Planned Operations - Contractor continues attempt to level jacket; will set superstructure, boat landing and finders; and make jacket, pile, and superstructure connections.

D. EQUIP STATUS - NONE

E. LOGISTICS - NONE

F. TRAINING - NONE

G. SAFETY - NO ACCIDENTS

H. MEDICAL - NO INJURIES

I. MORALE - High ad Tower #3 construction ends.

2. LT, MAYER, ROICC ACMR, SENDS.

Copy to:09...09A...02...05...09A2...FPO-1...1C1...1EA...PC-2...ROICC...AREICC...
AROICC...

DTG: 180400Z JULY 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 25C
1. SITUATION FOR PERIOD 15-17 JULY 1977 AS FOLLOWS:

A. WEATHER - Skies - Clear to Partly Cloudy
Winds - N, 5-10 Knots and SW, 10-20 Knots;
Seas and Swells from NE, 4-5 seconds, 2-3 feet, and from SW,
4-5 seconds, 3-6 feet.

B. ADMIN - Lt. Mayer returned to D.C. 16 July, returned to barge 17 July;
Mr. Brill returned to D.C. for period 18-20 July.

C. OPERATIONS
15 July - Jacket leveled within 5 inches between legs. Weld out of pile, jacket, and superstructure connections. Placed boat landing and fenders.
16 July - Made pile cut offs. Set superstructure within ½ inch of level. Continues weld out of connections.
17 July - Install NAVAIDS and solar panels; completed weld out of connections.
18 - 19 July - complete Tower #3 installation; site survey for tower #4.

D. EQUIP STATUS NO REPORT

E. LOGISTICS NO REPORT

F. TRAINING NO REPORT

G. SAFETY NO REPORT

H. MEDICAL NO REPORT

I. MORALE DOING FINE

2. LT, MAYER, ROICC ACMR, SENDS.

Copy to: 09...09A...02...05...09A2...FPO-1...1C1...1EA...PC-2...ROICC...AREICC...
AROICC...

DTG: 200400Z JUL 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 26A
1. SITUATION FOR PERIOD 18-19 JULY 1977 AS FOLLOWS:

A. WEATHER: Skies; clear to cloudy with infrequent showers SW 10-15 knots combined seas and swells from S, 3-6 feet and 2-4 feet, 4-5 seconds.

B. ADMIN: A tast, QA representatives, departed 18 July; G. Anadale, 0511, arrived at Tower #3 site 19 July.

C. OPERATIONS: 18 July - diver inspection - no discrepancies; preparations of welds for painting; first paint coat.
19 July - Final two (2) paint coats and tough up. Hydrographic survey under way to locate site 4.
20 - 21 July - Planned Operations - Complete hydrographic survey; place jacket 4 if environmental conditions improve

D. EQUIP STATUS: One (1) NAVAID light inoperative after one night; replacement available and used. Fog Horn Operational; time delay switch non-functionary; FPO-1 to research.

E. LOGISTICS: Four Site #4 - Five/ten hour transit from Little Creek by vessels DAMIEN/CRISTOBAL, respectively.

F. TRAINING: NO REPORT

G. SAFETY: NO ACCIDENTS

H. MEDICAL: minor injuries; cut fingers, twisted ankles, etc...

I. MORALE: Concerned with weather

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to: 09..09A..02..05..09A2..FPO-1..1C1..1EA..PC-2..ROICC..AREICC..AROICC.

DTG: 220400 JUL 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 26B
1. SITUATION FOR PERIOD 20-21 JUL 1977 AS FOLLOWS:

A. WEATHER: 20 July - Winds SW 10-20 knots; Seas 1 foot; swells from S, 3-4 ft. 5-6 seconds.
21 July - Winds SW 15-22 and NW 5-15 MPH; seas/swells SSW, 2-4 ft. ocassionally 5 ft, 4-5 seconds. Majority of each day on weather standby because of sea conditions.

B. ADMIN: PH3 Petrou arrived 20 July. SEACON/UCT ONE at Tower #2 site 1600 on 20 July.

C. OPERATIONS: 20 July - Located and set moor at site 4 location; on weather standby from 1030. UCT ONE commenced diving operations at Tower #2.
21 July - Rigged four lift of jacket #4 (0530-1030); set and orientated jacket (1615-2345). Remainder of day on weather standby. UCT ONE conducted dive operations at Tower 2.

D. EQUIP STATUS: NO REPORT

E. LOGISTICS: NO REPORT

F. TRAINING: NO REPORT

G. SAFETY: NO REPORT

H. MEDICAL: NO REPORT

I. MORALE: Weather forecast not favorable; concerned.

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to: 09..09A..09A2..05..02..FPO-1...1C1..1EA..PC-2..ROICC..AREICC(3)..AROICC..

DTG: 250400 JUL 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 26C
1. SITUATION FOR PERIOD 22-24 July 1977 AS FOLLOWS:

A. WEATHER: 22-23 July - Winds NW-NE 15-25 MPH and/or waves 3-7 ft. (ocassional 6-10 ft.), 5-6 seconds, from N-NE.
24 July - Winds change from N to SE 5-15 MPH; dual swells from NE 2-4 and E 1-2.

B. ADMIN: A. Brill and R. Collins (Crest QA) arrived 22 July. CDR Erchul and B. Co (Tera QA) arrived 24 July. CDR Erchul to depart 25 July (AM).

C. OPERATIONS: 22-23 July: Majority of both days on weather standby due to high winds and/or waves.
24 July: Off weather hours as of 0830 (total weather hours to date 110.5). Stabbed initial pile in each leg of jacket #4. Pile A1 driven 43 ft. w 040 at 57 BPM av 32 BPF. Pile B2 driven 44 ft. w/0400 at 57 BPM av 42 BPF. Pile C1 driven 19 ft w/040 at 57 BPM av 18 BPF. Jacket leveled within 2 ½ inches. UCT ONE completed phase I u/w inspection on tower #2.

D. EQUIP STATUS: NONE

E. LOGISTICS: DAMIEN provided transport from SEACON to LINDSAY for Government personnel.

F. TRAINING: NONE

G. SAFETY: NONE

H. MEDICAL: NO INJURIES

I. MORALE: IMPROVING WITH BREAK IN WEATHER

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to: 09..09A..09A2..02..05..FPO-1..1C1..1EA..ROICC..AROICC..AREICC(3)

DTG: 270400Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 27A
1. SITUATION FOR PERIOD 25-26 JUL 77 AS FOLLOWS:

A. WEATHER: 25 July - Winds SSW 15-25 MPH; Waves 4-6 ft. & 5-8 ft, 45 seconds from SW
26 July - Skies overcast occassional showers; winds 15-20 MPH from NE; waves 2-4 ft., 3 seconds, from NE

B. ADMIN: NO REPORT

C. OPERATIONS: 25-26 July - Welding/repair of A1-A2 & B1-B2 Pile Splices. Also approximately 12 hours weather time (total 122.25)
27-28 July - Planned operations include driving following piles: A2, B2, C1, A3, C2, B3, A4, C3

D. EQUIP STATUS: All Equipment operational

E. LOGISTICS: NO REPORT

F. TRAINING: NO REPORT

G. SAFETY: NO ACCIDENTS

H. MEDICAL: NO INJURIES

I. MORALE: UNDEFINED

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to:09...09A...09A2...05...FPO-1...1C1...1EA...PC-2...ROICC...AREICC(3)...AROICC...02

DTG: 290400Z JUL 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 27B
1. SITUATION FOR PERIOD 27-28 Jul 1977 AS FOLLOWS:

A. WEATHER: (27) Winds 15-25 from N.E.; Waves 1-3 Ft Building to 5-7, from N.E., 4-5 seconds.
(28) Winds 10-20 from N.-N.E.; dual swell conditions - Waves 3-6 Ft from N.-N.E., E.-N.E., and E.-S.E, in combinations thereof.

B. ADMIN: PHC Parker, FLTAVCOMLANT, arrived/departed 27 June (A.M.)

C. OPERATIONS: Pile A-2 driven 58 feet w/060 at 55 BPM, AV 35 BPF
Pile B-2 driven 58 feet w/060 at 55 BPM, AV 43 BPF
Pile C-1 driven additional 23 feet w/040 at 55 BPM, AV 43 BPF.
Completed repair and weldout of pile splices A2-3, B2-3, and C1-?.
Unable to resume pile driving because of dual swell conditions; on weather standby since 0445 28 Jul (Total weather time 141.5 through 28 Jul)

D. EQUIP STATUS: One barge generator in down status; under repair. Second generator operating effectively.

E. LOGISTICS: Transit to - from site less reliable until sea conditions improve.

F. TRAINING: None

G. SAFETY: No accidents

H. MEDICAL: No injuries

I. MORALE: Concerned with sea conditions; lessened by weld repairs

2. LT. MAYER, ROICC ACMR, SENDS.

DTG: 010400Z AUG 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 27C
1. SITUATION FOR PERIOD 29 - 31 Jul 1977 AS FOLLOWS:

A. WEATHER: (29 Jul) Winds N.W. 5-15; Waves 3-6 Ft, Occasional 7, dual swell conditions from N.E., N. N.E., and N. N.W.
(30-31 Jul) Winds 5-15, direction varies; swells 2-4 ft from S.E. - S., Seas less than ½ ft.

B. ADMIN: NONE

C. OPERATIONS: (29 Jul) On weather standby due to dual swell conditions
(30 Jul) Off weather standby as of 0445.
Pile A-3 driven 53 ft w/560 at 41 BPM, AV BPF 29.
Pile B-3 driven 53 ft w/560 ay 41 BPM, AV BPF 28.
Pile C-2 driven 54 ft w/040 at 52 BPM, AV BPF 74.
(31 Jul) Pile B-4 driven 59 ft w/560, 060, and 040 hammers; AV BPF 86 W/560
Pile C-3 driven 57 ft w/560 and 040 hammers; AV BPF 82 w/040. Total weather time 169.
Planned Operations for 1-2 August - Complete Pile driving of Tower 4.

D. EQUIP STATUS: Hammers:
040 - 2 Ea. operational; 060 - Valve Casting damage, replacement on order; 560 occasional maintenance/repair required.

E. LOGISTICS:
NONE

F. TRAINING:
NONE

G. SAFETY:
NONE

H. MEDICAL: Crew Member reinjured rib cage muscle during rigging operations.

I. MORALE: Increasing with good weather and pile driving success.

2. LT. MAYER, ROICC ACMR, SENDS.

DTG: 030400Z Aug 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 28A
1. SITUATION FOR PERIOD 1-2 Aug 77 AS FOLLOWS:

A. WEATHER: Winds - S.-S.W. 5-15
Seas - 0-½; Swells 3-5 Ft; 5 seconds period.

B. ADMIN: D. Raecke (FPO-1E5) arrived 1 Aug, departed 2 Aug
B. Cox (QA) departed 2 Aug.
Two Navy photographers arrived 2 Aug. Contractor Invoice #6 submitted for $9.7M; under ROICC consideration.

C. OPERATIONS: (1 Aug) Pile B-5 driven 51 Ft W/560 at 40 BPM; AV BPF 72; Final penetration 266.
Pile C-4 driven 62 Ft W/040 and 560; AV BPF 64 W/560.
(2 Aug) Pile C-5 driven 51 Ft W/560 at 39 BPM; AV BPF 56; Final penetration 266.
Pile A-4 driven 62 Ft W/040 and 560; AV BPF 85.

Planned Operations for 3-4 Aug: Complete Pile driving and set superstructure and boat landing.

D. EQUIP STATUS: 560 Hammer requires frequent maintenance; currently operational.
Auxilliary boiler down 1.5 hours; unable to power 560 hammer; currently operational. 060 hammer still inoperative.

E. LOGISTICS:
NONE

F. TRAINING:
NONE

G. SAFETY: No Accidents

H. MEDICAL: ROICC had crick in neck-currently operational; 1 crew member with intestinal virus.

I. MORALE: Discouraged by hammers; rapidly improving w/pile driving success.

2. LT. MAYER, ROICC ACMR, SENDS.

DTG: 050400Z AUG 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 28B
1. SITUATION FOR PERIOD 3-4 Aug 77 AS FOLLOWS:

A. WEATHER: Winds - S.-S.W. 5-10 and 10-20 MPH
Seas - ½-2 Ft from S.-S.W., 4 Seconds.
Swells- 2-4 Ft from S.-S.E., 6 Seconds.

B. ADMIN: D.Masso (FPO-1cl) departed 4 Aug
Navy Photographers departed 3 and 4 Aug
T.Dawson (NAVFAC) arrived 4 Aug at ROICC request. ROICC recommends
[illegible] Invoice #6 payment of $2.5M.(WIP $9.7M)

C. OPERATIONS:
3 Aug - Pile A-5 driven 51 Ft W/560 at 50 BPM, AV BPF 57; Final Penetration 267 Ft. Placed boat landing and barge fender.

4 Aug - Placed Superstructure. Weldout of Pile, Jacket, and Superstructure Connections.

<u>Planned Operations</u> - Complete Tower 4 by 7 Aug.

D. EQUIP STATUS: Crew performed preventative maintenance on 560 Hammer.
Repair Part for 060 Hammer due by 5 Aug.

E. LOGISTICS: NONE

F. TRAINING: NONE

G. SAFETY: No Accidents

H. MEDICAL: NONE

I. MORALE: Definitely on the Up-swing.

2. LT. MAYER, ROICC ACMR, SENDS.

DTG: 080400Z AUG 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 28C
1. SITUATION FOR PERIOD 5-7 Aug 77 AS FOLLOWS:

A. WEATHER: Winds - S.W. 5-10 and 18-22
Waves - S.-S.W. 2-4 and 3-5; 3-4 seconds; hot and humid

B. ADMIN: B. Walin replaced R. Collins as QA Inspector on 5 Aug 77

C. OPERATIONS:
(5 Aug) - Completed Weldout of Pile, jacket, and superstructure connections
(6 Aug) - Diver Inspection reports no structural defects, braced pipe 2-3 ft above sea bottom. Paint coating reported damaged from barge contact.
(7 Aug) - Divers complete underwater cleanup. Underwater painting unsuccessful due to waves and currents. Abovewater painting also unsuccessful; contractor suspects "DIMET" Paint spoiled; new supply on order. Contractor departs Site 4 at 2015; NAVAIDS operational; will complete painting at later date.

<u>Planned Operations</u>: Initiate construction at Site 1

D. EQUIP STATUS: Yet awaiting parts for 060 hammer.

E. LOGISTICS: Tug Kevin Candies W/barge 224 in tow, departed for Gulf 6 Aug.

F. TRAINING: NONE

G. SAFETY: One accident (Engineman was struck a glancing blow to back of neck by 8 Lb. sledge hammer)

H. MEDICAL: Engineman appears well; sent to Beach for X-Rays, precautionary purposes only.

I. MORALE: Leveling off at 7.5

2. LT. MAYER, ROICC ACMR, SENDS.

P.S. As of 6 Aug official weather time is a total of 170.25

09... 09A... 09B... 02... ~~[illegible]~~ 05... FPO 1... K1... IEA... ROICC... ARICC... ARE ICC... PC-2

DTG: 100400Z AUG 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 29A
1. SITUATION FOR PERIOD 8-9 August 1977 AS FOLLOWS:

A. WEATHER Winds SW-W 5-10 and 15-20 MPH; Seas 0-1 and 1-2 ft; Swells from S-SE 2-4 ft, 3-4 seconds.

B. ADMIN T. Dawson, NAVFAC, departed 5 August. C. Anadale, 0511, arrived 9 August. LINDSAY crew change was 9 August.

C. OPERATIONS
8 August - Jacket #1 set in approximate 83 ft. (MLW) Braced pipe approximate 3 ft above bottom; jacket out of level by 6 inches.
9 August - Stabbed P-1 piles of eac. leg; drove A-1 20 ft, B-1 11 ft, C-1 20 ft.

D. EQUIP STATUS Shaft of tort Swing Gear of Main Rig. fracturued. Rig operational under reduced weather conditions. 060 hammer down; 560 hammer requires minor maintenance.

E. LOGISTICS Replacement Shaft for main rig machined in Norfolk; due offshore by 10 August AM. Replacement Part for 060 hammer intranset to Norfolk.

F. TRAINING NONE

G. SAFETY NONE

H. MEDICAL NO INJURIES

I. MORALE 7.5

2. LT, MAYER, ROICC ACMR, SENDS.

Copy to: 09..09A..09A2...05...02...FPO-1...1C1...1EA...ROICC...AROICC...AREICC...PC-2

DTG: 120400Z AUG 77
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION; SITREP NO. 29B
1. SITUATION FOR PERIOD 10-11 Aug 77 AS FOLLOWS:

A. WEATHER Winds S.-S.W. 15-22
Seas $\frac{1}{2}$ - $1\frac{1}{2}$ Ft two seconds period,
Swells 3-5 and 2-4 Ft from S.-S.E. 3-4 seconds.

B. ADMIN C. Anadale (0511) departed 11 Aug

C. OPERATIONS Swing gear of main rig repaired.
(10 Aug) - Completed driving pile A-1 39 Ft W/040 hammer, AV BPF 26.
Completed driving Pile C-1 a total of 40 Ft W/040 hammer,
AV BPF 21. Pile A-2 driven 56 Ft W/040 hammer, AV BPF 57
(11 Aug) - Total 9 hours weather standby due to combination winds,
waves, swells. Total hours to date 180.75.
Pile A-3 driven 65 Ft W/040 and 560 hammer, AV BPF for 560 is 30.
Completed Driving Pile B-1 total of 38 Ft. W/040 and 560 hammer,
AV BPF W/560 is 5.
Pile C-2 driven 55 Ft W/560 hammer, BPF 18.
060 Hammer still inoperative, repair parts unavailable. 560
hammer operational but requires periodic maintenance.

D. EQUIP STATUS

E. LOGISTICS NONE

F. TRAINING NONE

G. SAFETY NONE

H. MEDICAL NONE

I. MORALE 8.0

2. LT, MAYER, ROICC ACMR, SENDS.
Copy to:
09...09A...09A2...02...05...FPO-1...1C1...1EA...FC-2...ROICC...AREICC...AROICC

DTG: 104003 AUG 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 29C
1. SITUATION FOR PERIOD 12-14 August 1977 AS FOLLOWS:

A. WEATHER: Winds SSW 10-15 knots and 18-22 knots.
Seas ½ to 1½ ft. from SW 2-3 seconds.
Swells 1-3 ft. 2-4 ft. from S 3-4 seconds.
Scattered rains on 14 August 1977.

B. ADMIN: LCDR Cullison arrived 12 August 1977.

C. OPERATIONS:
12 Aug. - A4 driven 53 ft w/560 average BPF 47. B2 driven 56 ft. 560 060. Average BPF of 560 = 28. Initiated punch list on Towers #2 and #3.
13 Aug. - Pile B3 driven 65 ft. 060 average BPF 44. Initiated planning Tower 4.
14 Aug. - Pile B4 driven 57 ft. w/060. BPF 67. Pile C3 66 ft/060.

D. EQUIP STATUS: 560 hammer operational. In need of repair. 060 hammer operational.

E. LOGISTICS:
SIDNEY CANDIES w/barge 262 departed our Gulf 13 August 1977.

F. TRAINING:
NONE

G. SAFETY:
NO ACCIDENTS

H. MEDICAL:
ROICC injured shin while boarding Tower 4. Recovering inimmencely.

I. MORALE:
7.0 w/progress slow but steady.

2. LT. MAYER, ROICC ACMR, SENDS.

Copy to:
09...09A...09A2...05...02...FPO-1...1C1...IEA...ROICC...AROICC...AREICC...PC-2

DTG: 170400Z AUGUST 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 30A
1. SITUATION FOR PERIOD 15-16 AUG 77 AS FOLLOWS:

A. WEATHER: Winds from SSW-SW 10-15 and 15-25 mph. Seas from SSW ½-1 ft. and 1-2 ft. Swells from S, 1-3 ft, 3-4 seconds. Frequent squall activity on 15 August 1977.

B. ADMIN: UCT-ONE aboard SEACON arrived Tower #4 15 AUGUST. A. Brill, AREICC, departed LINDSAY for D.C., 15 August., completing 8 weeks duty at sea. Sound photographer, FLTAVCOMLANT, arrived on Derrick Barge 16 August 1977.

C. OPERATIONS:
(15) Piles A4-C4 driven to within 4 ft of design penetration; blow count favorable (90 with 060 hammer after 2-day set up; and 50 with 060 hammer, respectively). Weld-out of pile and jacket connections. Attempt to install boat landing unsuccessful due to barge heave/roll. Punch list on Tower #2 near completion.
(16) Continued weld out of pile and jacket connections. Installed boat landing and barge fenders. Punch list Tower #3 complete; punch list Tower #4 near completion. UCT-ONE completed phase I and II underwater insepction of Tower #4.
(17-20) Planned operations - install superstructure and complete Tower #1.

D. EQUIP STATUS: Maintenance requirements of hammer no longer effect operations.

E. LOGISTICS: Tug ROBBYN J. w/barge 374 in tow departed for Gulf 16 August 1977.

F. TRAINING: NONE

G. SAFETY: NO ACCIDENTS

H. MEDICAL: NO INJURIES

I. MORALE: Flying high as ACMR construction nears end.

2. LT. MAYER, ROICC ACMR, SENDS.
Copy to:
09...09A...09A2...02...05...FPO-1...1C1...1EA...PC-2...ROICC...AROICC...AREICC(3

DTG: 190400Z AUGUST 1977
FROM: ROICC ACMR
TO: OICC
SUBJ: ACMR TOWER INSTALLATION: SITREP NO. 30B
1. SITUATION FOR PERIOD 17-18 AUGUST 1977 AS FOLLOWS:

A. WEATHER: (17) Winds from SW 15-20 knots; increasing 20-30 mph. Waves from SSW 2-4 ft.; increasing 6-9 ft. from SSW.
(18) Winds 10-15 mph from SW changing to NE; waves 3-5 ft. from S changing to N. Frequent periods of moderate/heavy winds and rain.

B. ADMIN: NO REPORT

C. OPERATIONS: (17) Set superstructure; completed weld out of pile-jacket connection Weather standby from 1945.
(18) Off weather standby 0500. Additional two (2) hours weather standby during morning. Diver underwater inspection reports no discrepancies. Misc. welding.
(19 - 20) Contractor hopes to complete tower #1 by 20 August (PM) if weather permits (improves)

D. EQUIP STATUS: no discrepancies

E. LOGISTICS: derrick barge scheduled to depart installation site by 20 August. Crew boat to remain behind for survey information.

F. TRAINING:
None

G. SAFETY:
No accidents

H. MEDICAL:
1 person injured back in fall from mobile crane when curtosy handle pulled loose.

I. MORALE:
Reserved joy.

2. LT. MAYER, ROICC ACMR, SENDS.
Copy to:
09...09A...09A2...02...04...FPO-1...1C1...1EA...ROICC...AROICC...AREICC (3)..PC2

APPENDIX G

ACMR SLIDE PRESENTATION

(1) INTRODUCTION

Construction of the Air Combat Maneuvering Range was a unique endeavor for the Navy, and specifically Chesapeake Division of *NAVFACENGCOM* which was responsible for the management and execution of this $13,000,000 Offshore Construction Project.

(2) RANGE SCHEMATIC

The basic purpose of the project was to provide suitable offshore platforms for installation of electronics equipment as part of a sophisticated air combat training range for pilots. The range provides for the simultaneous tracking of up to 20 aircraft as they engage in combat maneuvers, and fire simulated rather than live missiles. The system then electronically computes missile trajectories and records hit and miss results. This was a critical project for the Fleet in that it was to benefit naval air combat training to the tune of $90,000,000 savings in missile, drone, aircraft mishap, and personnel costs; and, in the end result, would provide for increased safety and pilot proficiency.

Chesapeake Division was assigned management responsibilities in November 1975. The initial schedule called for installation during the summer weather window of 1978. However, due to the criticality of the project to the Fleet, *CHESDIV* was encouraged to shoot for a target date one year earlier. This left only 20 months for selecting an A & E, designing, bidding, awarding a construction contract, fabricating, transporting and installing the four towers on site...Obviously little time for error or redo.

(3) LOCATION MAP

Some of the main design problems centered around the environmental conditions at the project's location. Specially, the towers were to be located 15 to 30 miles off the coast of Kitty Hawk, N. C.; adjacent to the infamous Bermuda Triangle; in water depths ranging from 83 to 105 feet.

In designing the towers, we realized that ocean engineering is not yet a perfected science. Three different wave theories were considered for the various water depths of the four structures. The

structures which were to have a 20 year design life; they were to be capable of surviving a 50 year storm which included 145 mph sustained winds with gusts to 175 mph; and 61 foot wave heights atop an 8 foot tide surge. The design was to accommodate bottom scour, marine growth, and corrosion, as well as satisfy extreme electronic tolerances such as location accuracy within two meters, orientation within 3 degrees, and a stability of $\pm$ 1 foot at the top of the structure. Various alternative designs were considered including a floating structure, gravity structures, and mono-column and multi-pile structures.

(4) ARTIST RENDITION

Finally, a three-legged, steel jacketed type structure, as depicted by this artist's rendition, was selected as the most economical. In executing the project, we found that neither designers nor construction contractors were familiar or enthused with ASPR, DOD, or Navy contract procedures. Essentially, offshore construction is on a cost-plus basis at a day rate of $60,000 and the customer assumes all risk and liability. So when we started talking in terms of:

- Design Liability
- Fixed Price Contract
- With No Material or Labor Escalation
- Fixed Completion Date with Possible Liquidation Assessments
- The Provision for Bonds, Insurance, Buy American Acts, Contractor Quality Control
- Retention of Progress Payments
- Wage Rates, Labor Laws, OSHA Requirements
- Warranties, Contractor Liability for Latent Defects
- Even the Possible Auditing of a Contractor's Books during Change Order Procedures ...

Well, there just weren't many people beating down our doors to do us any favors.

The end result was we were able to develop the design which was prepared by Crest Offshore of Tulsa, Oklahoma, which accepted the 20 year design life liability negotiated as a cost of the fee.

In addition, we had provisions for involvement of the A & E throughout the construction phases in an inspection capacity. An independent engineering firm provided quality assurance on the design to avoid potential problems later.

On the construction side, an experienced contractor was considered imperative. Thus, all interested contractors had to satisfy pre-qualification requirements before being given the opportunity to bid. In addition, equipment, material, and certain personnel requirements were included as part of the specifications; requirements for highly specialized materials were minimized; the warranty and latent defect provisions of the contract were modified; and unit price provisions for weather hours, and remedial work such as drilling and jetting, were included as part of the bid total. We felt, at least, that we had developed a contract which would have a partnership concept between the Government and the successful contractor.

(5) FABRICATION YARD

In the end, a fixed price contract for fabrication, transportation, and installation of the four *ACMR* towers was awarded to Brown & Root Marine Operators, Inc. on 14 January 1977, with a completion date 8 months later. This tight construction schedule was required to complete installation of all four towers before the close of the weather window and advent of the September hurricane season, common to the Cape Hatteras region. Brown & Root chose to fabricate the components of the four towers at its Green's Bayou facility on the Houston ship channel.

(6) OFFICE

In order to maintain some control of the construction schedule, a project office was set up in the fabrication yard to be manned by a *ROICC* or *REICC* on a full-time basis. Their main purpose was to keep abreast of construction progress and, when necessary, provide responsive solutions to contractor questions or problems. It was the type of project where we could not afford the typical 10 day, 5 day, or even 1 day response to a potential problem.

(7) TOWER DRAWING

As a preview to construction, let me first describe the three main components of the *ACMR* structure. The first is the jacket which extends from just above the surface water, down through the column, and actually rests on the sea floor. The jacket serves as a template or guide for the second main component- heavy wall, 42 inch diameter piles which extend from the top of the jacket, down through each of the three jacket legs and nominally 250 feet into the sea floor. The third component is the superstructure - the tip of the iceberg so to say. It sits atop the three pilings and extends 75 feet above the water surface. The superstructure has two platform decks - the lower for supporting the solar panels used to collect solar energy to power the instrumentation package which is positioned on the top deck.

(8) ROLLED SECTION

& (9) The majority of tubular members were formed from large sheets of A-36 fine grain steel plates in Brown & Root's pipe mill. The column sections, 1.5 to 2 inches thick, were first rolled into short 5 or 10 foot cans,...

(10) GIRTH WELDING

And then joined or spliced together by welding into their required lengths. Fine grain A-36 steel has a reduced grain size over that of conventional A-36 steel, and as a result, has improved strength, and resistance to brittle fracture and fatigue failure. Thus, it will be better able to survive the harsh loadings and cool temperature of the Cape Hatteras region.

(11) SMALL TUBE FABRICATION

& (12) The *ROICC* staff surfaced one problem by exercising the Government inspection option. Independent testing showed certain of the rolled members to have lost their resistance to brittle facture. Closer inspection revealed that members with low diameter/thickness ratios were being cold-rolled to the maximum extent possible and

then finished by hot-rolling. The inordinate degree of cold-forming was considered detrimental to the materials resistance to fatigue or brittle fracture.

Post-fabrication testing is uncommon in offshore industry. Contracts normally specify the material properties of the plate necessary to satisfy design requirements; but some of the detrimental effects of fabrication - such as we encountered - oft go undiscovered.

(13) HOT PLATE

to (17) Our final resolution was that all plates to be made into tubulars with diameter/thickness ratios less than 20 would be entirely hot-formed. This sequence of slides shows rolling of the plate after being heated in a furnace to 1200° F. Subsequent testing showed no appreciable change in the strength or fracture resistance properties of the original plate.

(18) BOAT LANDINGS

Meanwhile, outside, welders were busy fabricating boat landings.

(19) ANODE

The sacrificial anodic protection system,

(20) DECKS
&
(21) and decks for each of the superstructures.

(22) RAIN

There were occasional reprives from the tight construction schedule.

(23) TORNADO

Such as when a small tornado rocked, lifted and completely decimated one-half of the *ACMR* office spaces. Perhaps it was an omen of good tidings to come, since the Government's half of the building was left completely intact.

(24) SUPERSTRUCTURE FABRICATION

to Each of the superstructures was fabricated on their side and

(27) then uprighted in a two crane lift operation for placement of jib cranes, solar panel frames, NAVAIDS, and final painting.

(28) GFE

All government furnished equipment was completely unpacked in the fabrication yard, inspected for damage, tested, and repacked for shipment to sea... Again, to avoid unnecessary delays once offshore.

(29) JACKET FABRICATION

& The jackets were being fabricated in another section of the yard.

(30) One side of each jacket was welded out between two legs, and the remaining two sides framed into the third leg.

(31) LEG LIFT

&

(32) This third leg was subsequently lifted, rotated and set down atop the other two legs for weldout and painting.

(33) JACKET

Only the top 20 feet of each jacket was painted for this portion would be required to survive in the highly corrosive tidal and splash zones of the sea.

(34) FOUR JACKETS

Total fabrication time from receipt of material to completion of a single jacket and superstructure was 9 weeks. Because fabrication of each tower was staggered and overlapped, total fabrication time of all four towers - involving over 3,000 tons of steel and 100,000 man-hours of effort - was 12 weeks.

(35) JACKET MOVES

By the first week in June, the structures were ready for transportation to sea. Four large mobile cranes were used in unison to walk each jacket from the fabrication area to pierside...

(36) BIG JOHN

where this 500-ton barge crane was waiting.

(37) JACKET LIFT

to (39) The crane hooked on, lifted the jacket, and then was maneuvered alongside a cargo barge.

(40) JACKET LOWERED

& (41) The crane barge was carefully aligned such that the jacket could be lowered into 6 awaiting saddles.

(42) TWO JACKETS

A second jacket was loaded end-to-end to the first.

(43) WALK OF SUPERSTRUCTURES

& (44) Similarly, the superstructures were walked to pierside, and loaded adjacent to the jackets.

(45) SEA FASTENING

Sea fastenings - consisting of wire rope and brace pipe - were welded between the barge and the structures to preclude any danger to the structures during the 1700 mile journey to the east coast sites. A marine surveyor was additionally required to inspect the barge and sea fastening, and certify their integrity for ocean transport.

(46) TOW

to (48) Each barge was led by a 3500-HP tug, down the Houston Ship Channel, through the Gulf of Mexico, around the tip of Florida and northward along the east coast. A government representative accompanied each of the tows to maintain surveillance of the towers and to provide *CHESDIV* with a daily point of contact for the location and status of tow. Tow speed ranged between 5 and 10 knots. Thanks to a brisk, near shore Gulf Stream current, the 1700 mile journey was completed in 12 days, 2 full days ahead of schedule.

(49) BUOY

The site location for the first tower had been marked earlier by a survey boat.

(50) *LINDSAY*

The derrick barge - the *H. A. LINDSAY* - was the first vessel to arrive on site. The *LINDSAY* has a crane capacity of 350 tons and can support a crew complement of 85 men. To take maximum advantage of every bit of good weather, both the contractor's crew and government inspection staff would split their forces into two 12-hour shifts in order to provide a continuous 7-day per-week, around-the-clock, construction and construction surveillance capability. Once in location, the *LINDSAY* was positioned in a six point moor and rigged for work.

(51) CRANE BARGE

When weather was deemed favorable, the cargo barge with the first two towers was brought alongside.

(52) RIGGERS
&
(53)

Riggers were lifted atop the high jacket leg to fasten the lifting slings.

(54) READY FOR LIFT

With the cranes main block hooked in, sea fastening was removed.

(55) JACKET IN AIR
&
(56)

Soon the jacket is in the air, and the tugs pull the cargo barge away from the now pendulum-like jacket.

(57) JACKET LOWERED
to
(59)

The jacket is then lowered into the sea. Because each leg of the jacket is sealed, the jacket floats horizontally one foot above the surface.

(60) RIGGERS

Riggers are required to balance themselves on the legs and interconnecting brace pipe to disconnect the main hook from the lifting slings, and refasten it to righting slings connected to the top of each jacket leg. A single diver then opens flood valves at the base of each leg.

(61) JACKET ALMOST VERTICAL

As the legs begin to flood, the jacket begins to right itself.

(62) JACKET VERTICAL

& (63) Finally, with the jacket in its proper orientation, the crane rotates over the intended location, and lowers the jacket to the sea floor.

(64) JACKET ALONE

The total time for setting a jacket varies between one-half and three days. This includes time for verifying location and water depth; and for leveling and orienting the jacket once it's in place. But the large variance in time accumulates while awaiting periods of good weather. Weather conditions were not always this favorable.

(65) BIG WAVES

& (66) In one case, less than ten minutes after setting the jacket, winds increased from 10 to 45 knots, and the wave heights increased from 3 to 12 feet shortly thereafter...Partially submerging the jacket.

(67) PILE BARGE

It is vital that piling should start as quickly as possible after the jacket is set. A severe storm could possibly force the *LINDSAY* offstation and, worse, upend the jacket thus, the first objective is to stab and drive lead piles in each leg. The pile barge is brought alongside.

(68) PILE SUSPENDED

The 177-ft lead piles weigh 75 tons apiece.

(69) STABBING PILE

to (71) Stabbing of the piles proves somewhat difficult because of barge motion which is transmitted to the crane and its pendulum-like load.

(72) LEAD PILES IN PLACE

The stabbing operation is repeated three times until there is a lead pile stabbed in each leg.

(73) HAMMERS

The contractor is required to have three sizes of pile driving hammers available. The hammers vary in capacity from 120K to 300K ft-lbs of energy.

(74) 040 HAMMER

For the lead piles, the 040 hammer - 120,000 ft-lbs -- is sufficient.

(75) & (76) 040 DRIVING

Pile driving begins and continues.

(77) PILES DOWN

The lead piles reach a depth of 70 feet below the sea floor. To reach design penetration of 250 feet, four add-on lengths of piling are required to be affixed atop each lead pile.

(78) to (81) STABBING ADD-ON

Because of closer tolerance, the add-ons generally prove more difficult to stab than lead piles.

(82) & (83) WELDING SPLICE

It takes five welders six hours to complete each pile splice

(84) & (85) WELDING INSPECTION

Each splice is inspected by ultrasonic means. This particular weld checks O.K.; some did not. Defective welds are required to be arc-gouged, rewelded, and re-inspected at a penalty of 3 to 6 hours in construction delays.

(86) LIFT OF 560

Driving is anticipated to be tougher this time. The 560 hammer - 300,000 ft-lbs - is called into action.

(87) 560 ATOP

The 560 hammer is the size of a box car and weights 140 tons itself.

(88) PILE DRIVING
&
(89) Once again driving is underway.

(90) STORM

But pile driving is not always continuous.

(91) WAVE

Because the contractor would be reimbursed at a unit bid rate of $2500/hr for every hour in which weather was the sole cause of his inactivity...

(92) MAINTENANCE
&
(93) But would receive no compensation whenever his non-work status was the fault of his own actions or equipment,...

(94) DOCUMENTATION

It was imperative that the government inspectors keep accurate logs of weather conditions and construction progress.

(95) PILES DRIVEN

Finally, each of the piles are at design depth.

(96) LEVELING
to
(98) Upon completion of pile driving, each of the jackets were out of level. Jack stands were welded to the low jacket leg and pile. Two 100-ton hydraulic jacks and the barge crane were used in unison to raise the low side of the jacket to within acceptable level tolerance.

(99) BOAT LANDINGS
to
(102) The boat landings and barge fenders were lowered on to prefabricated stabbing cones.

(103) SHIM PLATES

Shim plates were inserted in the annulus between jacket and pile, and welded out.

(104) PILE CUT OFF

While welding continues, excess lengths of pile are cut off at proper elevation.

(105) SHIM PLATES

It takes two solid shifts - 24 hours - of twelve welders each to complete weld out of the shim plates.

(106) CARGO BARGE

It is now time to set the superstructure.

(107) S-S AND HOOK

The main block is hooked in while welders remove the sea fastening.

(108) to (112) S-S LIFT

The crane again exerts the necessary effort, this time to lift the 75 ton superstructure. The stabbing cones of the superstructure fit into the tops of the three piles. The crane operator uses a delicate touch to mate the units. This operation has been likened to threading three needles at the same time.

(113) & (114) WELD OUT

What remains is weld-out of the superstructure/pile connections and completion of weld-out of the boat landings.

(115) SOLAR PANELS

Installation and hook up of the solar panels and navigational aids.

(116) & (117) DIVER

A diver's inspection ensured there was no subsurface damage to the structure during installation...

(118) LASER

& The contractor also used a laser gun to precisely locate each

(119) tower within ± 1 yard relative to bench marks on land.

(120) PAINTING

& With final touch-up painting, the *LINDSAY* retrieved its anchors

(121) and pulled away from a completed tower.

(122) *SEACON*

But the Navy's role was not yet completed. Navy divers from Underwater Construction Team One were brought to each tower site aboard *CHESDIV's* ocean construction platform *SEACON*. Their task was to perform a subsurface acceptance inspection for the *ROICC*.

(123) UNDERWATER

to These Seabee divers used light-weight dive gear and hard wire

(126) communications to report the condition of each of the structural joints, and gather baseline documentation of soil conditions and profile. This latter information will be used in future scour analysis studies.

(127) INSPECTION TOPSIDE

Each of the towers received an inspection well done.

(128) SUNSET

to Construction of the *ACMR* towers was a success story. Through the

(130) combined efforts of the contractor, *NAVFAC* and *CHESDIV* (Navy engineers) and Seabee personnel - and not least some divine blessings - the four *ACMR* towers were completed 37 days ahead of schedule with two no-cost change orders, and 10% under the bid award.

END

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DTIC